SE-SES4000 - Fundamentals of Systems Engineering (Fall 2018)

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Faculty of Technology, Natural Sciences and Maritime Sciences

Course Description

- Fundamental of system Engineering (September)- 5 days
- Project management for complex problems – september 24-28 september
- Set of seminars during fall/spring
- Project class
- Individual assignement
- Home group project

INTRODUCTION

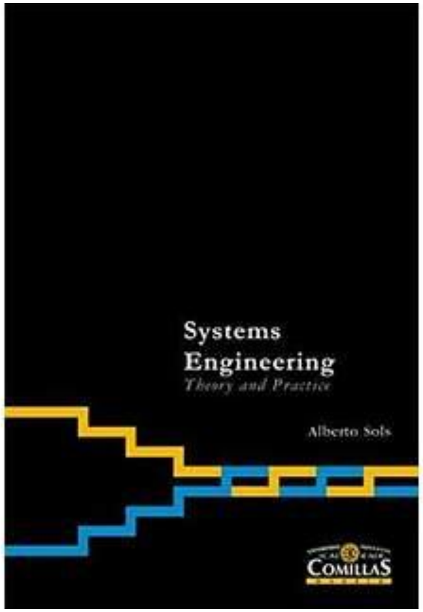
TO

SYSTEMS ENGINEERING

Goals

- Have a solid conceptual understanding of systems engineering and its potential applications.
- Have a good foundation of the systems engineering framework.
- Understand the key characteristics of the systems approach.
- Know what stakeholder and system requirements are, understanding their characteristics, differences, and relationships.
- Understand the role of the design concepts in the systems approach.
- Know how to transform requirements into the architecture of the system

Systems Engineering textbook



Course textbook (required)

Additional Reading
Set of paper on Canvas
Internet resources

Grading

- **Class Team Project SE and PM**
- **Individual Homework**
- **Home Team project**

Assessment type/scale ➔ pass/not pass

Team Project

- ✓ **Choose one problem or opportunity, formulate it and conduct the five exercises indicated in the materials (from identification of stakeholders, to verification methods of detailed requirements).**
- ✓ **Work by default in the proposed problem, although you may pick a similar one of your choice (that needs to be approved by the course instructor).**

Team Project

- ✓ The teams will work on the in-class team project. Each team will give on Friday 31/ 09/18 a 15-20 minute presentation to the class (in which all team members are to participate), describing their project and the results of their assessments throughout the systems engineering framework for the case selected.

- ✓ Each presentation will be evaluated both regarding contents and quality.

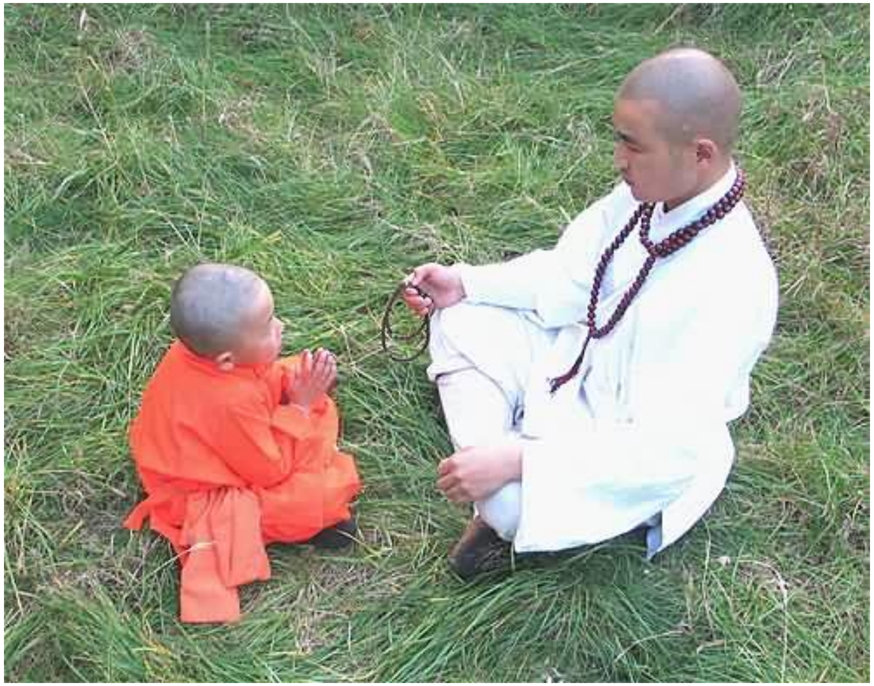
- ✓ Grade ➔ besttatt or Ikke Bestatt

Week Plan (tentative)

	Monday	Tuesday	Wednesday	Thursday	Friday
9:15 - 12:00	Book chapter 1] Introductions Course goals Homework – initial description Presentation # 1 Team Project - Exercise 1 (goal)	Book chapters 2,3,4,5] Presentation # 4. Discussion pre-reading papers 1 & 2 Team Project - Exercise 2 (CONOPS). Team Project - Exercise 3 (stakeholders).	[Book chapter 6] Presentation # 5. Team Project - Exercise 5 (design concepts). Discussion of pre-reading paper 5	Book chapters 7, 9] Presentation # 7 Presentation # 8 Discussion of pre-reading paper 6	Presentations of Team Projects. Sandwich feedback *Group dynamics - The 10 Commandments of the Systems Engineer* Homework – detailed description Course evaluation and wrap-up
13:00 – 14:00	Lunch	Lunch	Lunch	Lunch	EXPECT TO FINISH CIRCA 13:30
14:00 – 16:30	Presentation # 2 Presentation # 3	Discussion pre-reading papers 3 & 4 Work in Teams - Exercise 4 (stakeholder requirements).	Presentation # 6. Team Project - Exercise 6 (system requirements and verification methods).	Team Project – Exercise 7 (system validation strategies). Presentation # 9 Discussion of pre-reading paper 7	

Rights and Rules
Stop and Go
Toyota

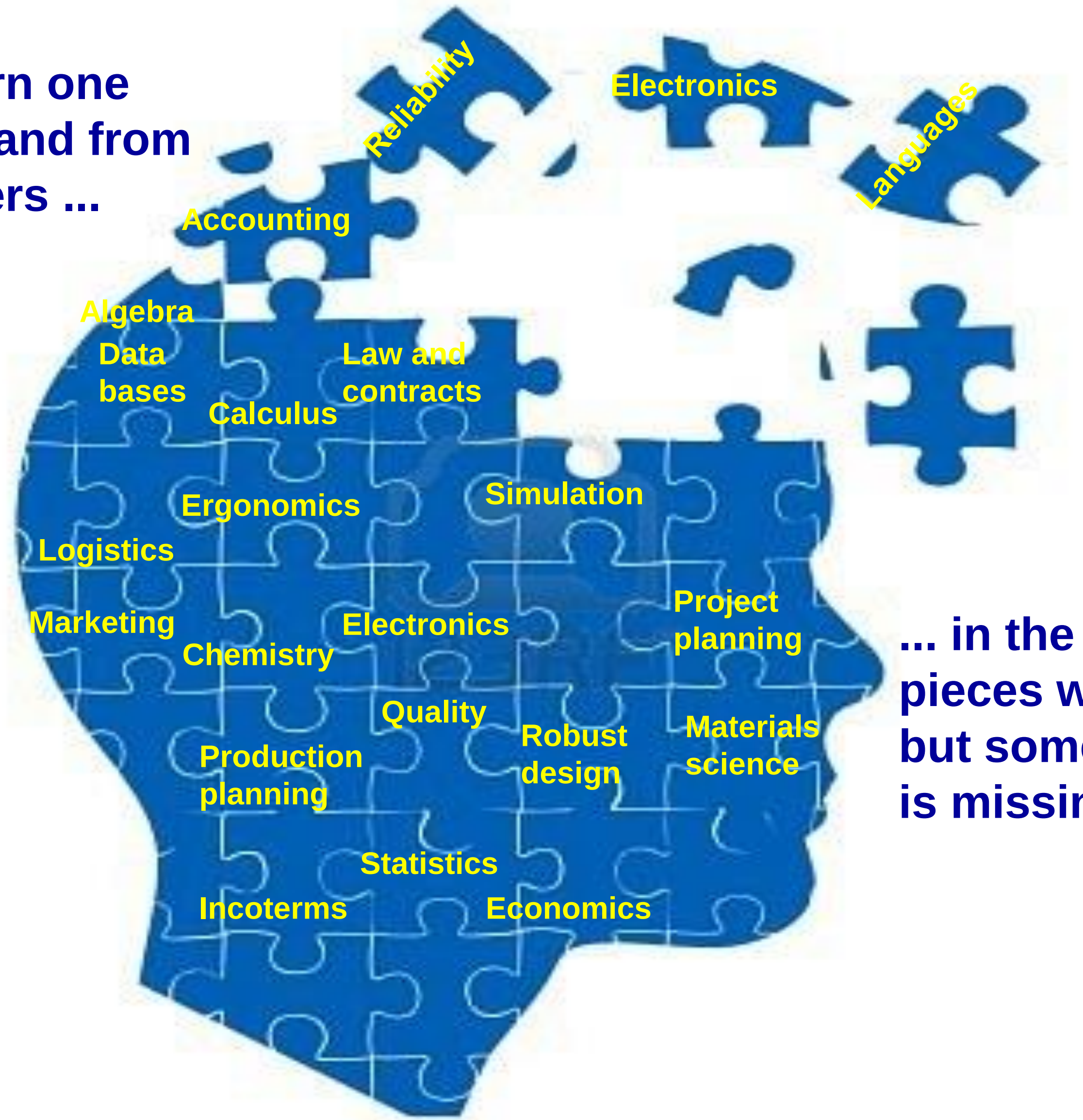
Master and student



It would be nice for each of us to have a Master that would teach us all we need to develop and grow personally and professionally!

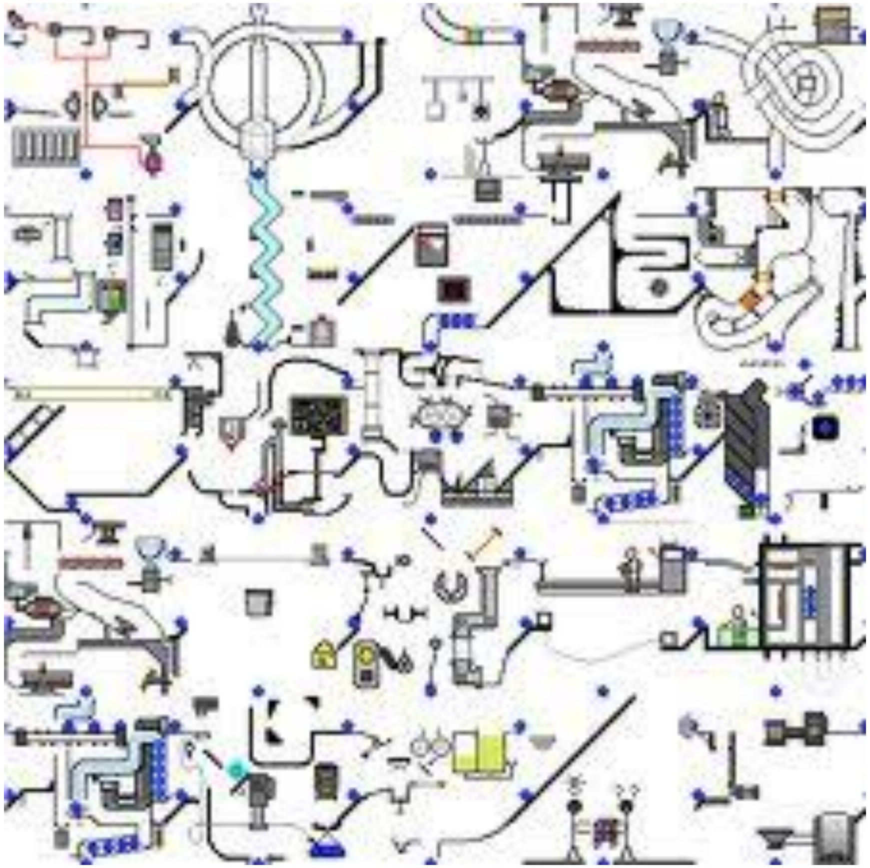
Knowledge gaps

Instead, we learn one piece at a time and from different teachers ...



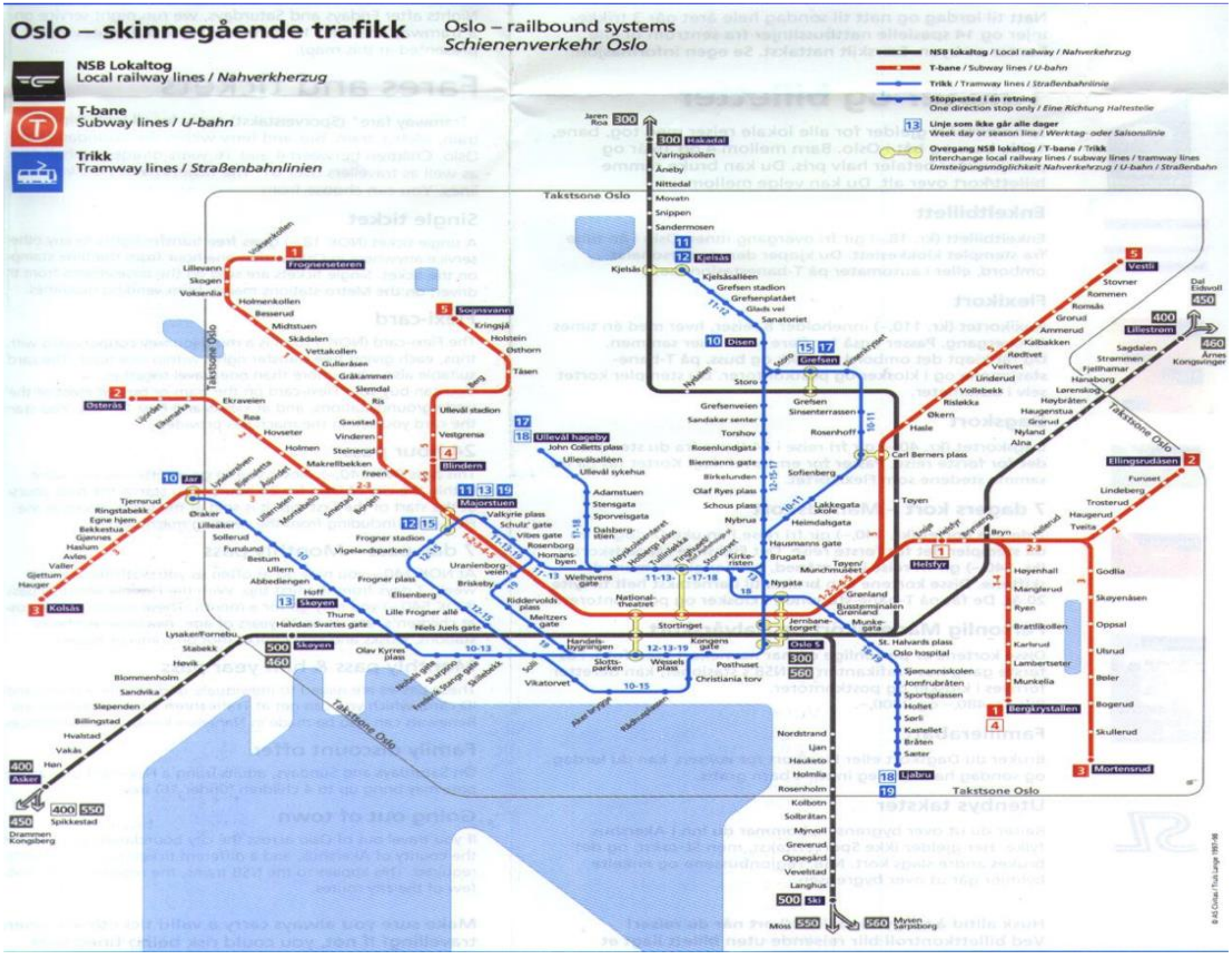
... in the hope that the pieces will fit together, but sometimes the glue is missing ...

Systems and complexity

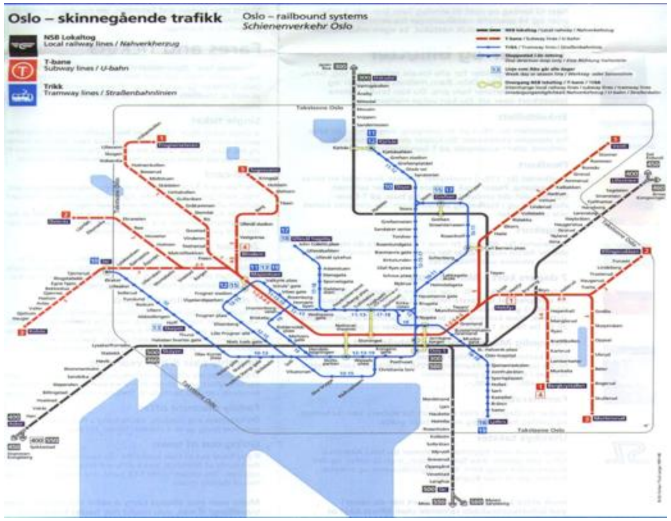


Many complex 'systems' are far more than the sum of its constituent parts or elements, being the interfaces or glue that links them a truly essential ingredient.

Oslo public transportation



Oslo public transportation

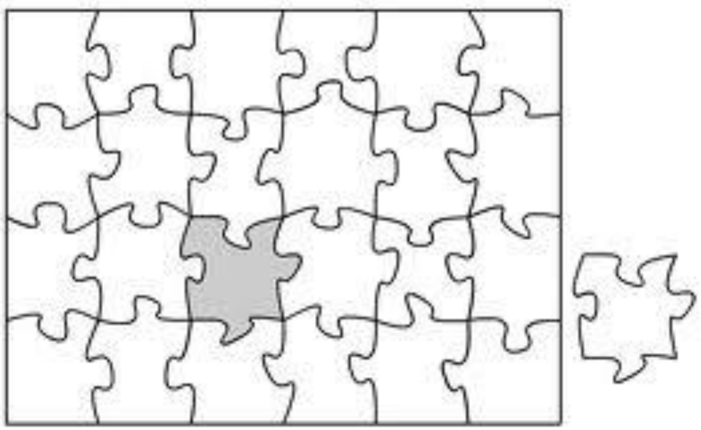


- ✓ **Several transportation means operated in a coordinated fashion, but each one with its own operational and supportability issues.**

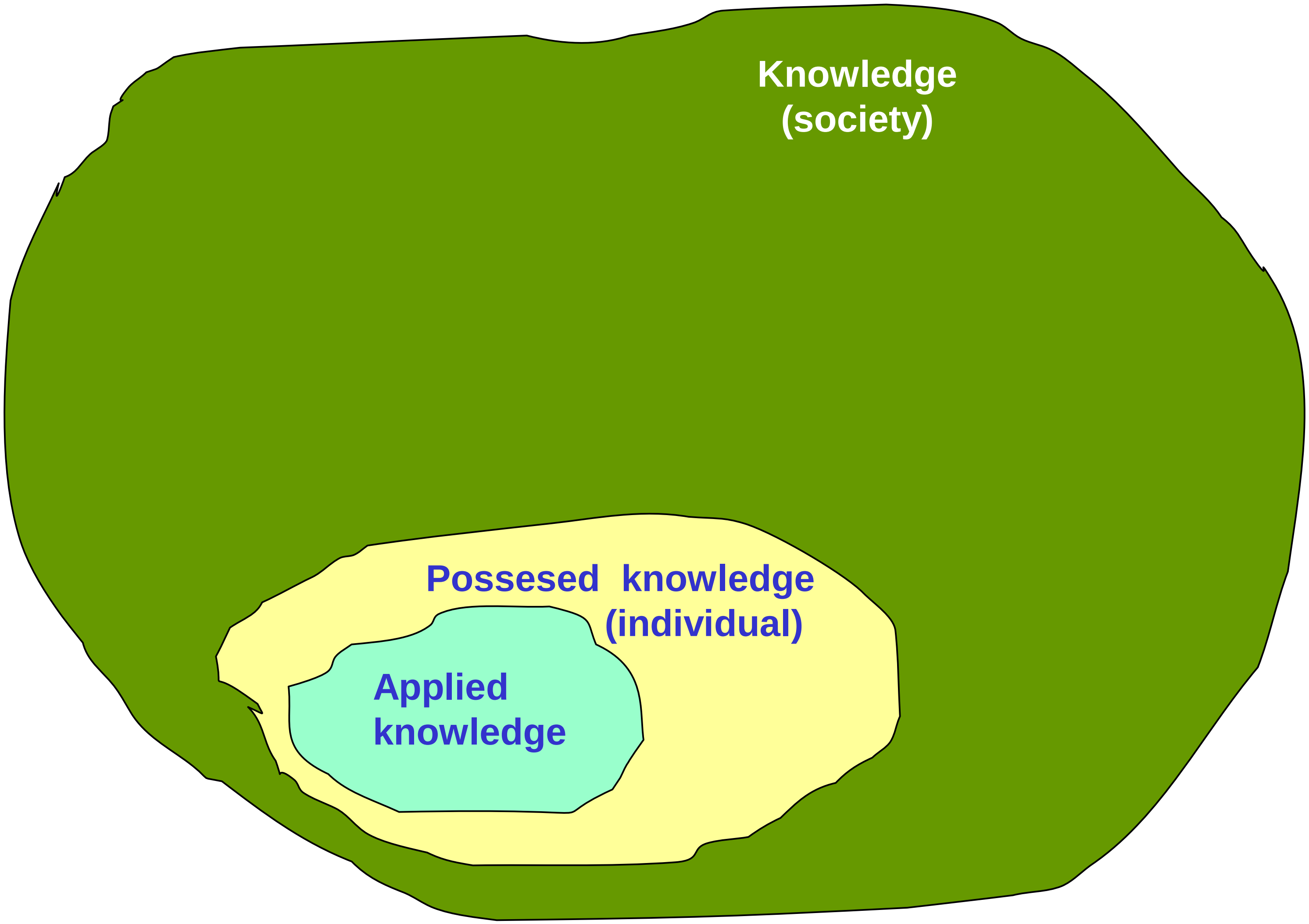
- ✓ **There are multiple stakeholders (users, operators, maintainers, managers, certifying entities, regulatory agencies, ...), often with conflicting goals or needs.**

- ✓ **The end goal is a social service, but financial aspects have to be considered, and legal, and ergonomics, and ...**

- ✓ **Global view is ESSENTIAL!**

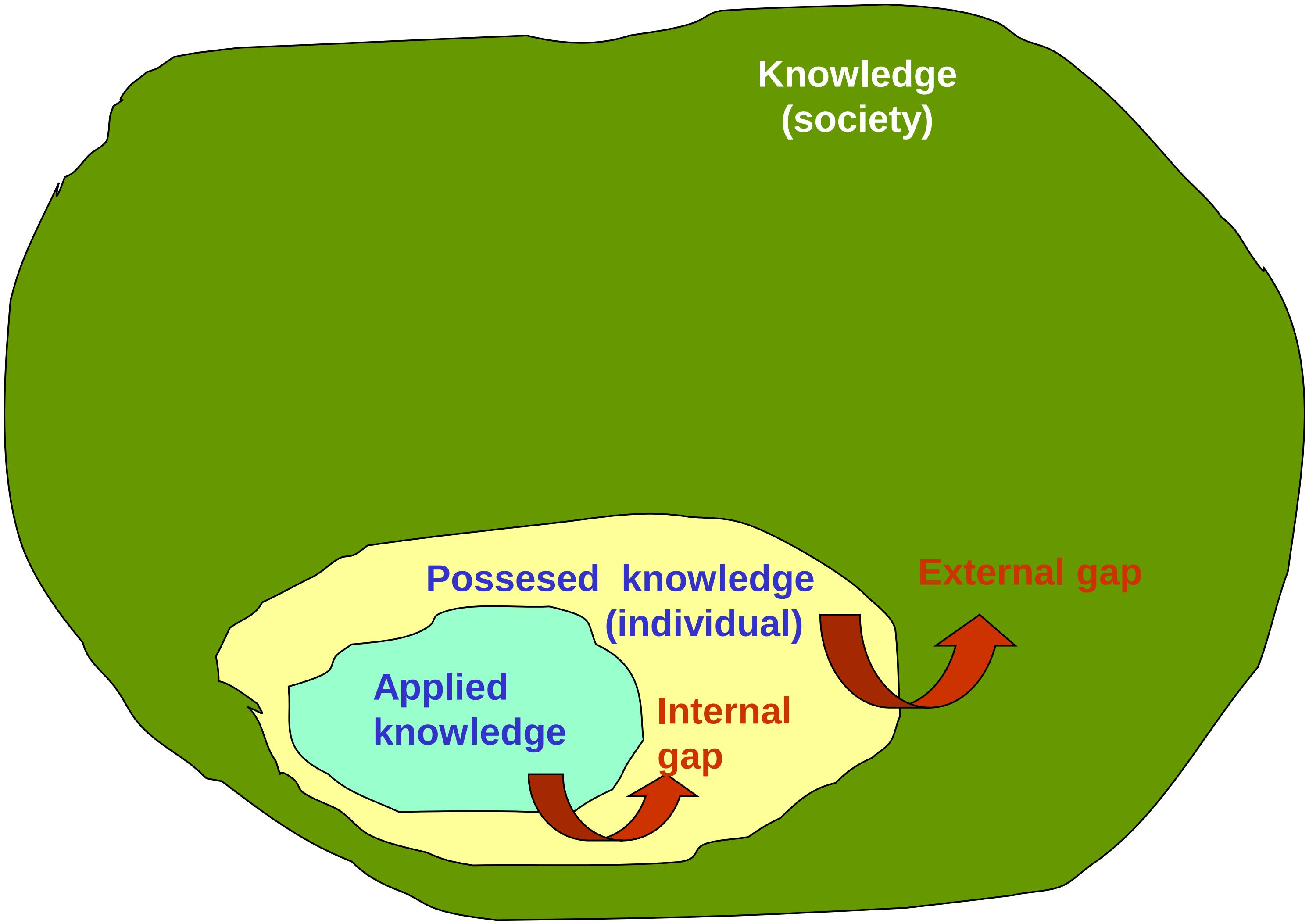


- **SE gives the overview of the origin and purpose of systems engineering.**
- **It sets the framework for the rest of courses in the Program!**
- **Systems engineering is the glue that binds the pieces together!**

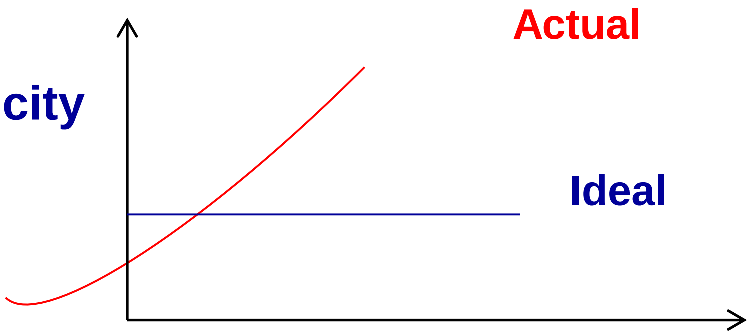

Knowledge
(society)
Possesed knowledge
(individual)
Applied
knowledge

Knowledge gaps

Learning organisation or organisationel learning



The systems engineer



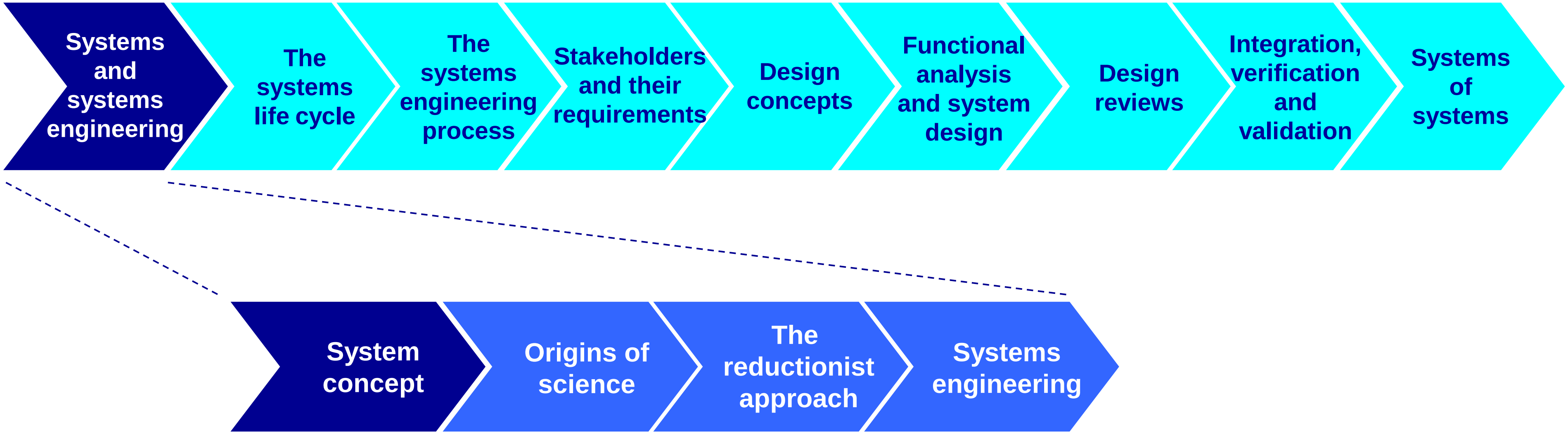
In spite of his broad education the systems engineer does NOT intend or pretend to know everything. Instead, he knows WHAT to ask, and WHAT to do with the responses!

ASK THE EXPERT !

The roller coaster

"Why not save the money and just throw up right here?"

Professional life may be like riding a roller coaster, with exciting ups and downs: great feeling of capability following initial learning, demoralization when facing problems in industry, and systems engineering coming to the rescue!


Systems and systems engineering
The systems life cycle
The systems engineering process
Stakeholders and their requirements
Design concepts
Functional analysis and system design
Design reviews
Integration, verification and validation
Systems of systems
System concept
Origins of science
The reductionist approach
Systems engineering

Systems

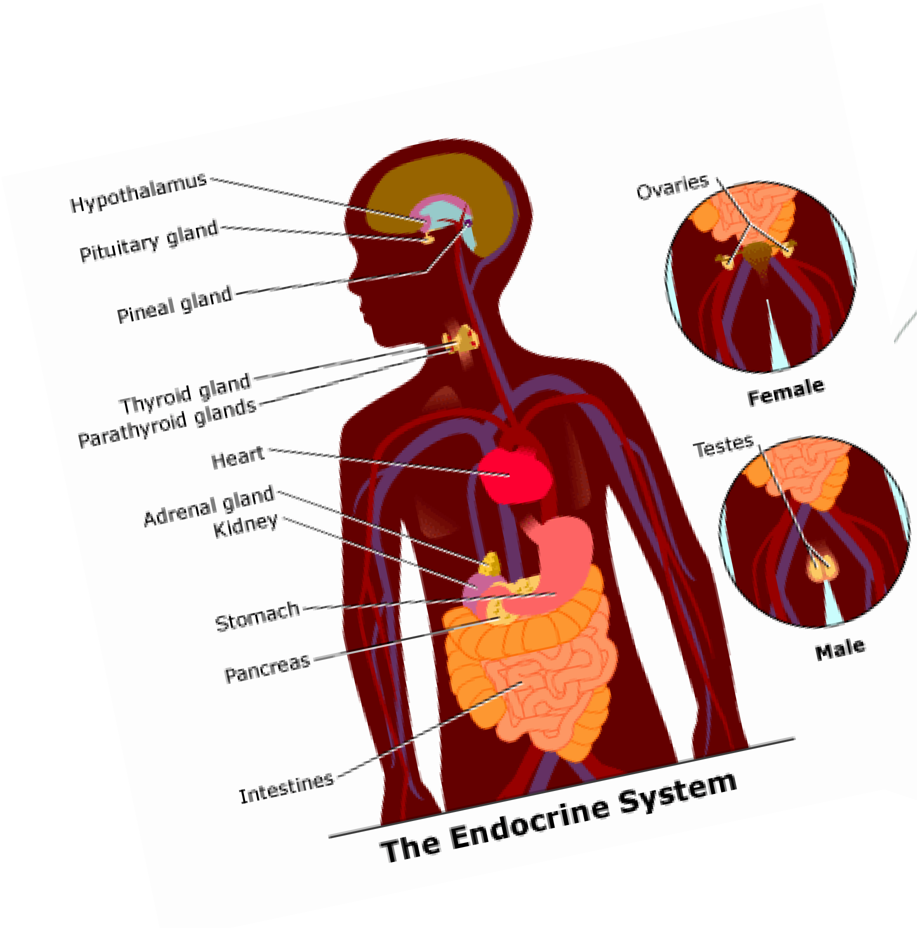
- The term system comes from the Greek $\sigma\upsilon\sigma\tau\varepsilon\mu\alpha$, which refers to a set of elements that duly inter-related contribute to the achievement of a certain goal.

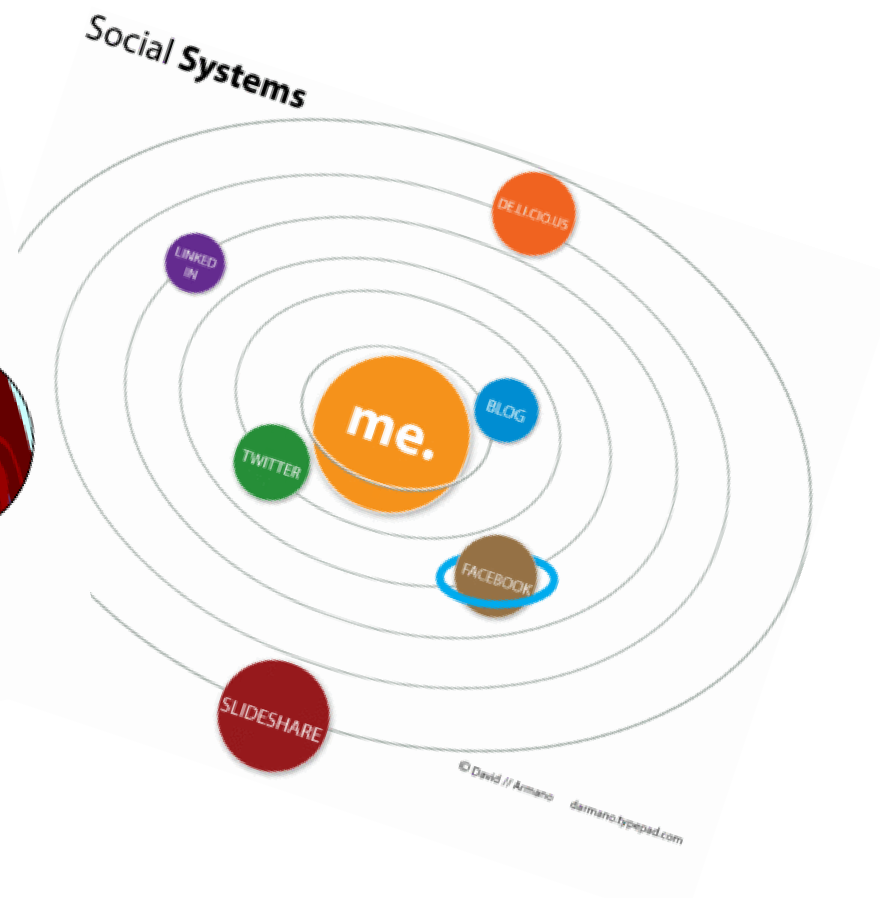
- Many definitions have been given for the term system, although all share the existence of a goal or purpose to be achieved.

- Not every random group of items, methods, or parts is therefore a system, because of their absence of unity, functional relationship and useful purpose!

Holistic view of the systems

Biological System





Systems

Military systems

Medical Systems

Systems


Problem Solving
Development of Application Technologies
Development of New Methodologies
Society
Mathematical Technology
Open Systems
Information Technology
Organizations
Human
Administrative Engineering

Systems

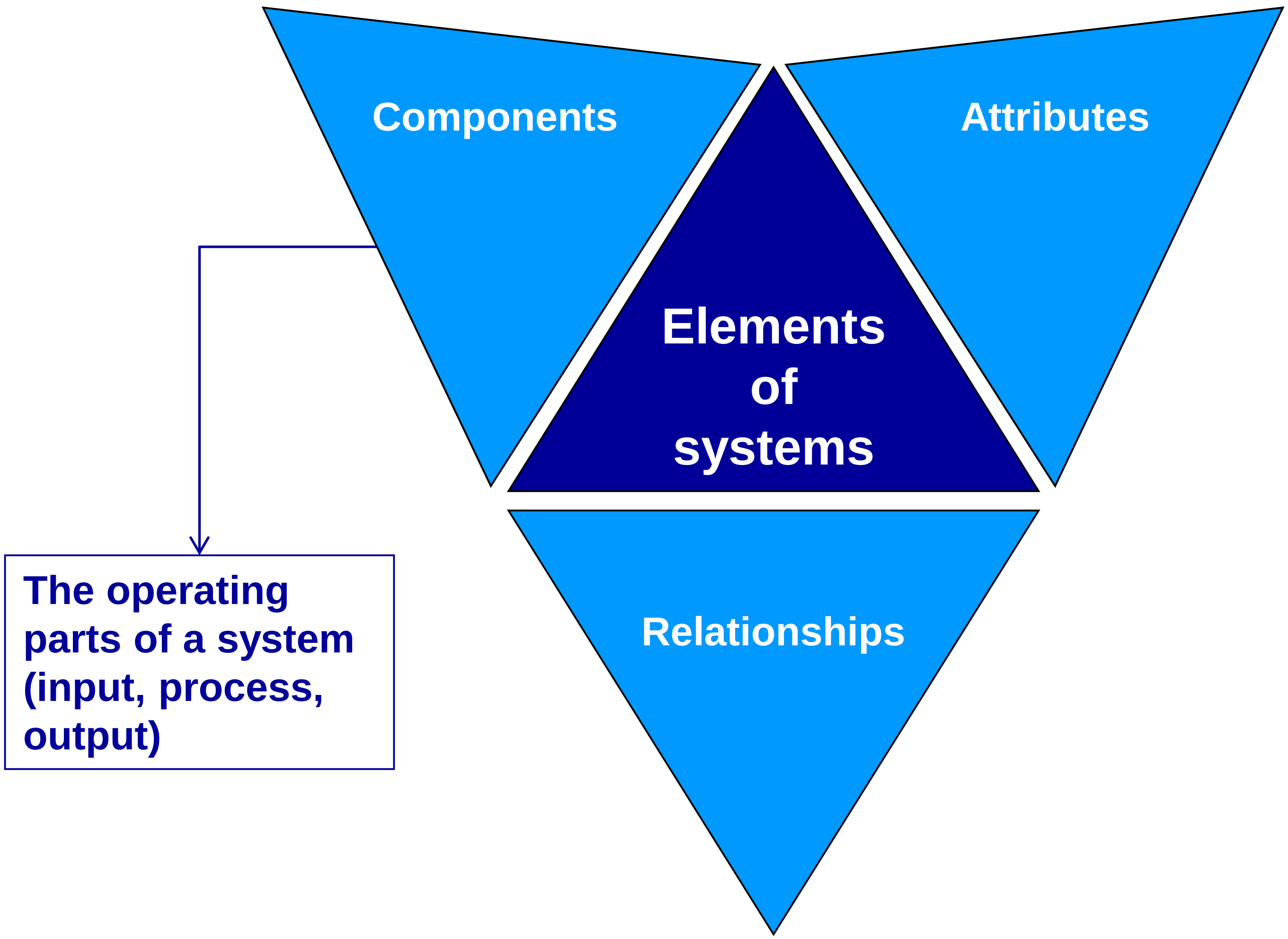
Trading systems

Systems

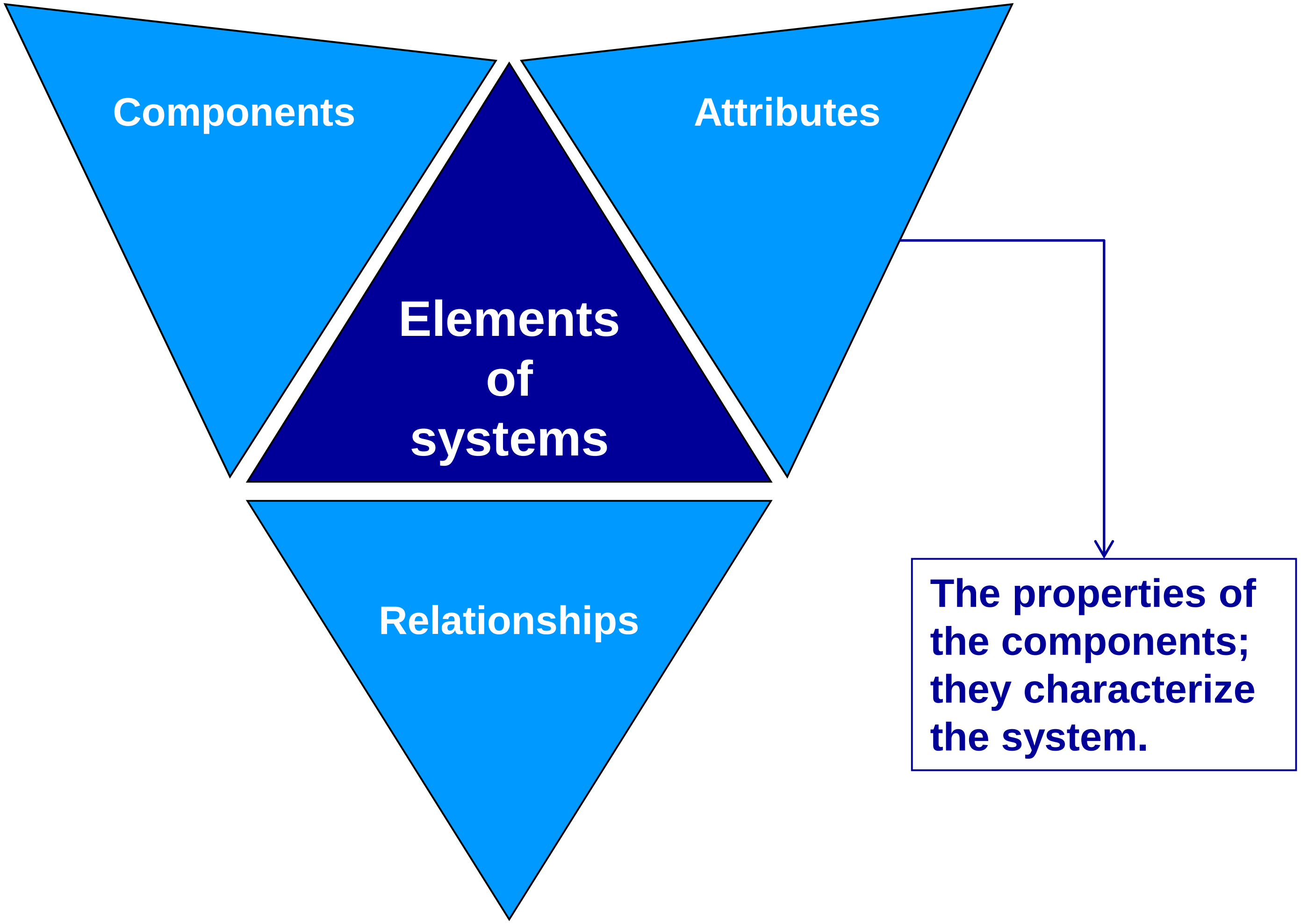
Airport systems

Others Systems ?

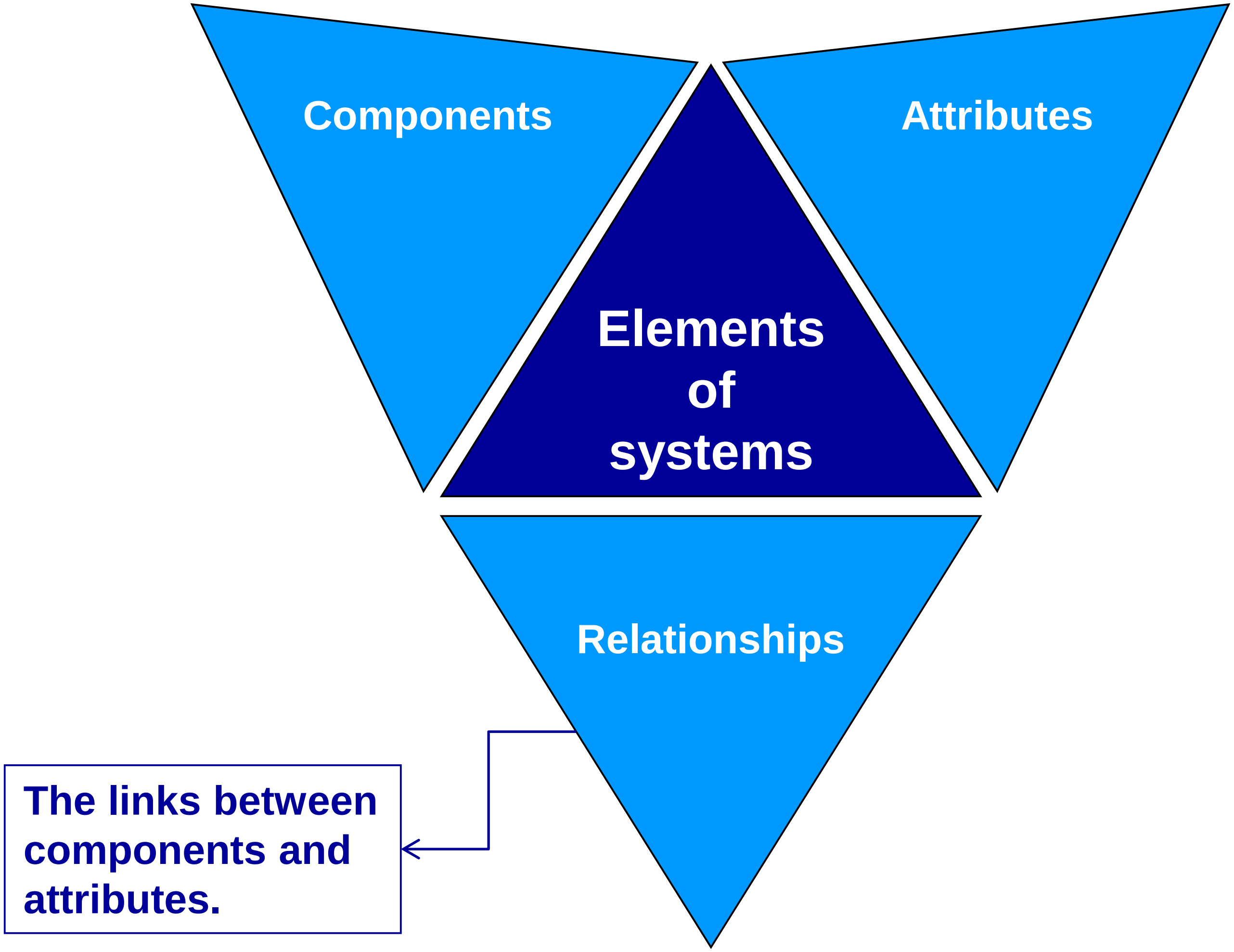
Systems


Components
Attributes
Elements of systems
Relationships
The operating parts of a system (input, process, output)

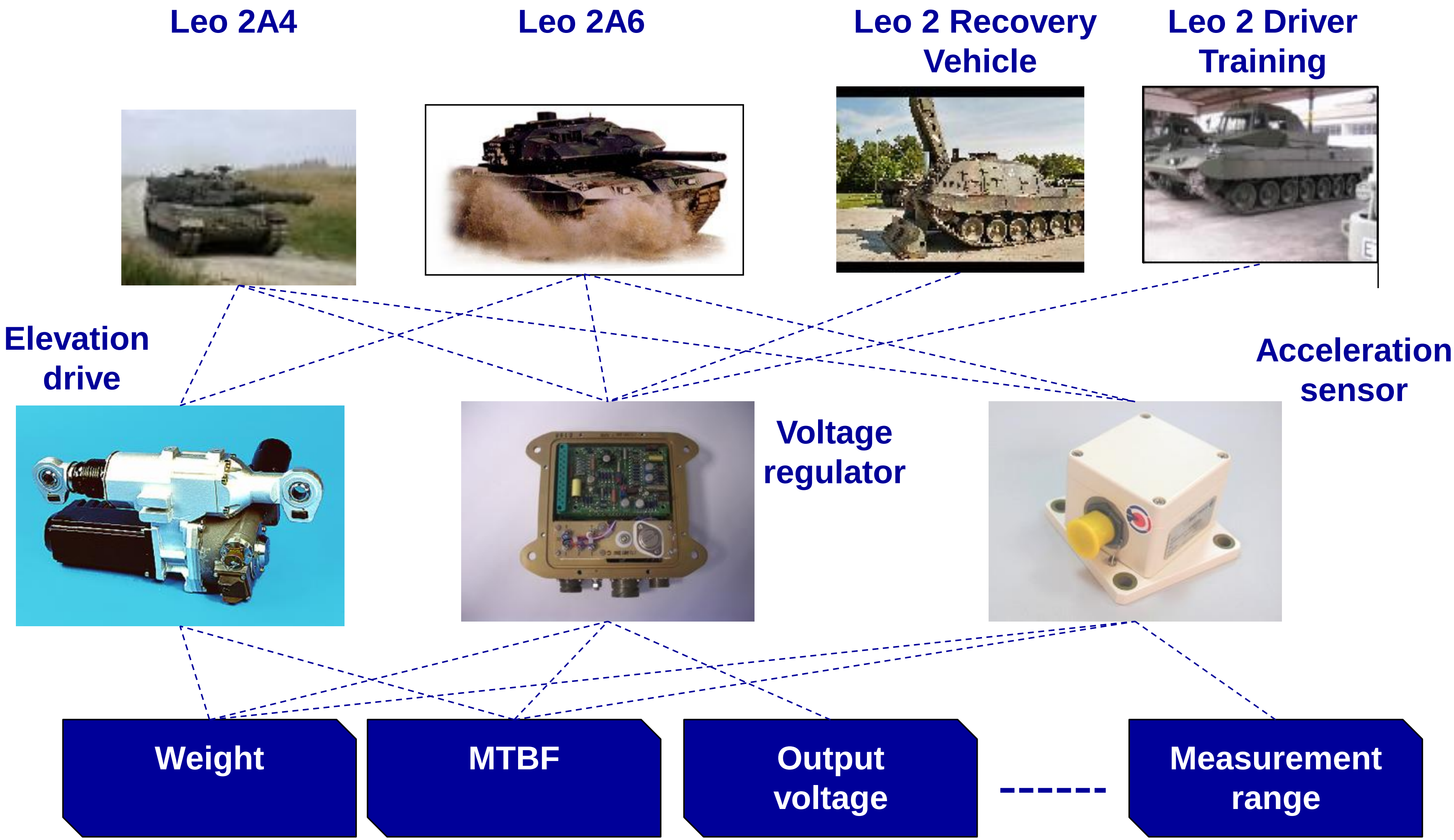
Systems


Components
Attributes
Elements of systems
Relationships
The properties of the components; they characterize the system.

Systems


Components
Attributes
Elements
of
systems
Relationships
The links between
components and
attributes.

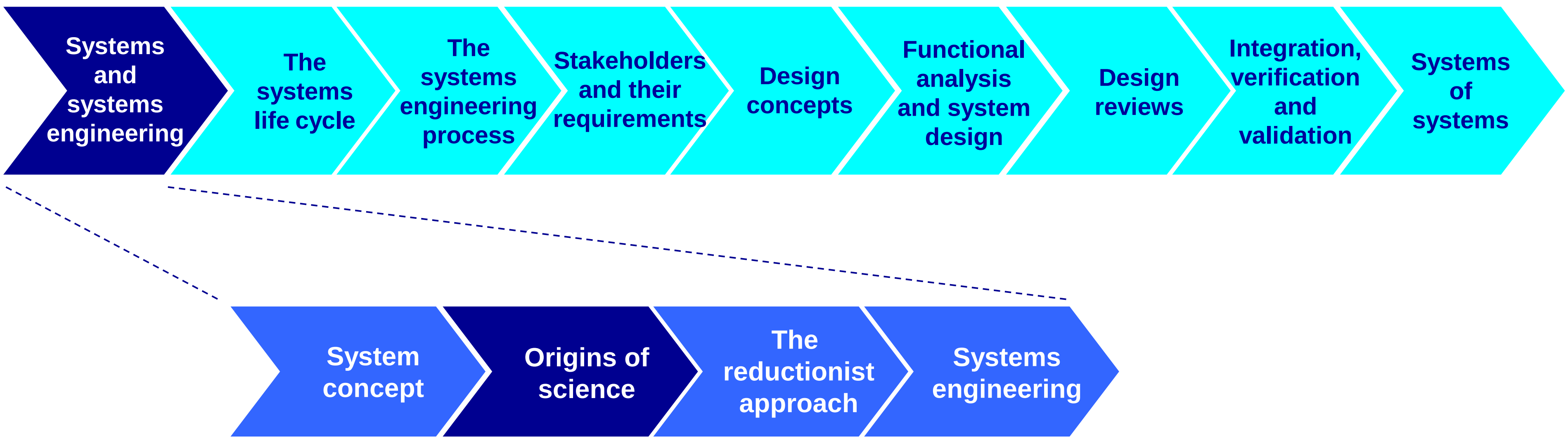
Example


Leo 2A4
Leo 2A6
Leo 2 Recovery Vehicle
Leo 2 Driver Training
Elevation drive
Voltage regulator
Acceleration sensor
Weight
MTBF
Output voltage

Measurement range

Systems approach

Holistic and modular views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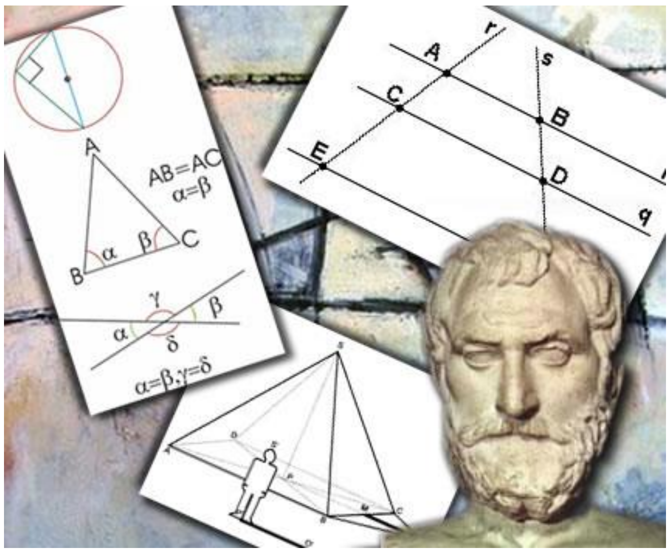
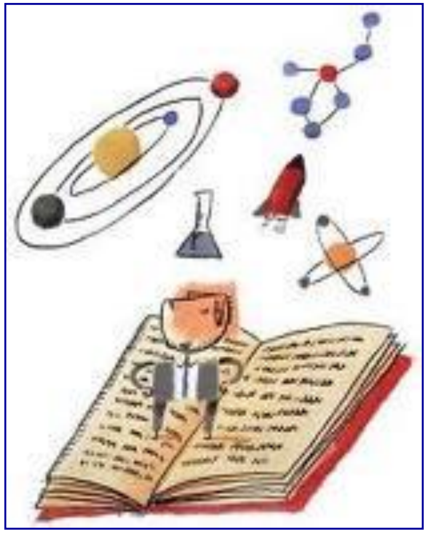
Thales

Thales' theorem ?



- **Thales was a pre-Socratic greek philosopher who lived in Miletus (Asia Minor) ca. 624 to 546 b.C.**
- **Thales is known as the first true scientist, given that he tried to explain natural phenomena without reference to gods and mythology.**

Science



Science:

1. The observation, identification, description, experimental investigation, and theoretical explanation of phenomena.

2. Such activities restricted to a class of natural phenomena.

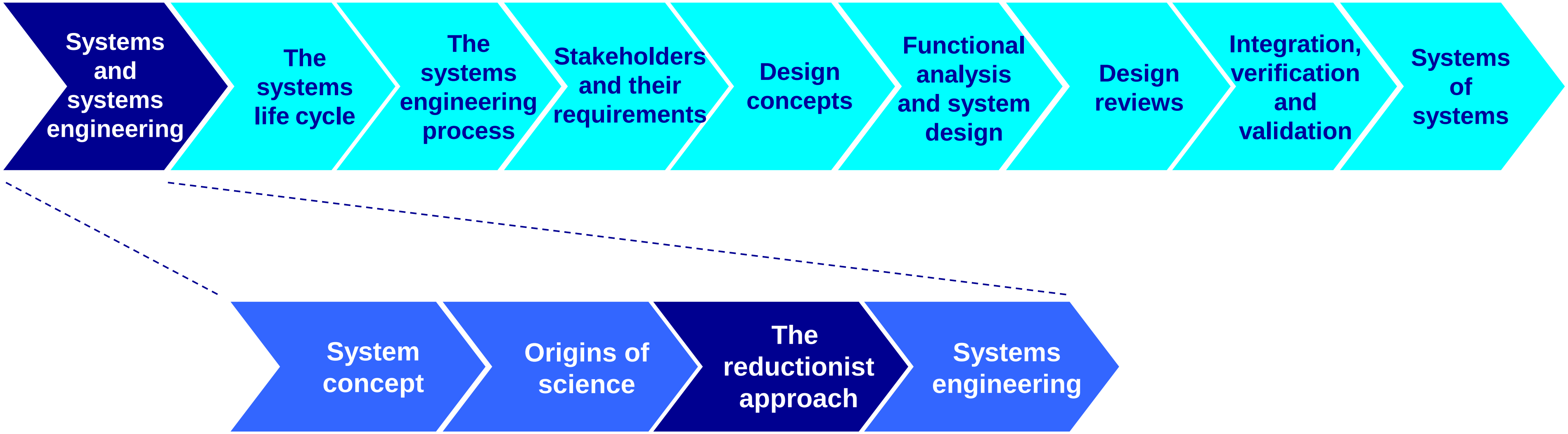
3. Such activities applied to an object of inquiry or study.

Science

- Science as we know it originated about 2.500 years ago in the ancient Greece.
- Science comes from the Latin *scientia*, which means knowledge.

Engineering

- **Engineering is the application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems.**
- **We will deal with systems designed and developed by man.**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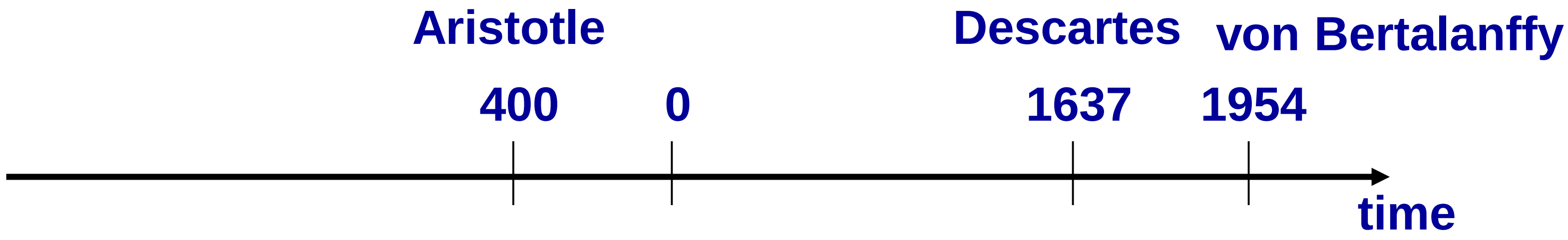
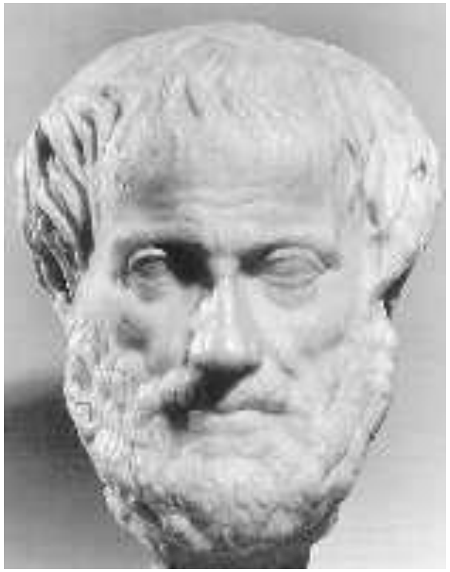
From Theology to System theory



Aristotle	Teleology (systems have a purpose)
Descartes	Reductionism
von Bertalanffy	General Systems Theory

The end goal of systems

The Greek philosopher Aristotle considered that the objects tried to achieve their end goal. He applied his teleological analyses (search for goal) to physical and biological phenomena.



TEOLOGICAL language is frequently used in biology in order to make statements about the functions of organs, about physiological processes, and about the behavior and actions of species and individuals. ➔ function, purpose, and goal

The end goal of systems

- Too frequently we face dilemmas in our projects, in the form of questions like:

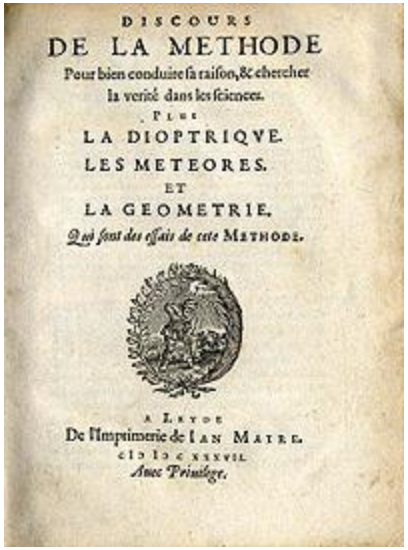
- Should this particular analysis be conducted?
- If so, in what depth and to what extent?
- ...

- In case of doubt, go back to chapter 1, page 1 .....

  .... ask yourself again, What were we trying to do,

  solve or achieve in the first place?

Common sense

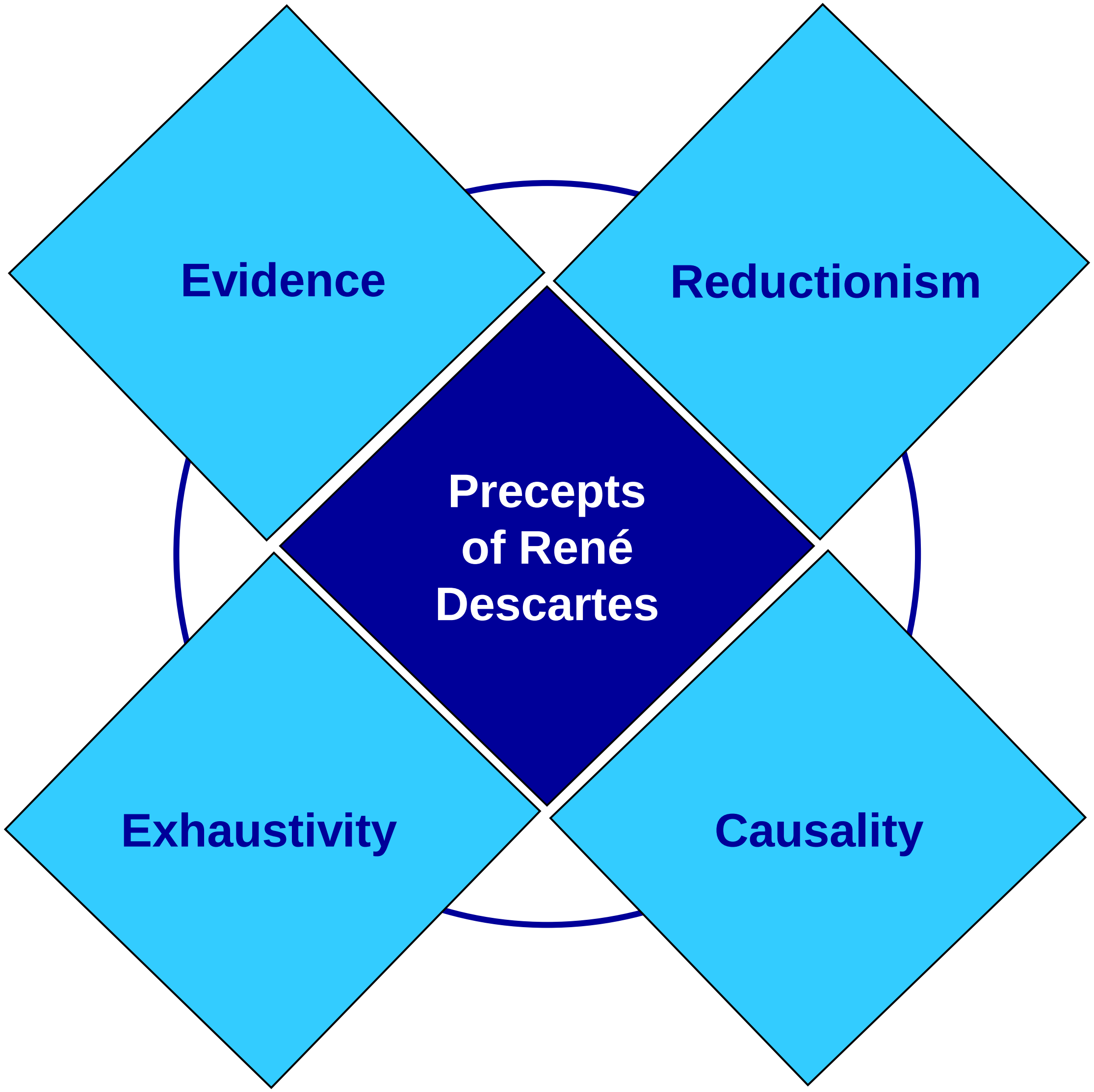


DISCOURS
DE LA METHODE
Pour bien conduire sa raison, & chercher
la verité dans les sciences.
PLUS
LA DIOPTRIQUE.
LES METEORES.
ET
LA GEOMETRIE.
Qui sont des essais de cete METHODE.
A LEYDE
De l'Imprimerie de IAN MAIRE.
CIↃ IↃ C XXXVII.
Avec Privilege.

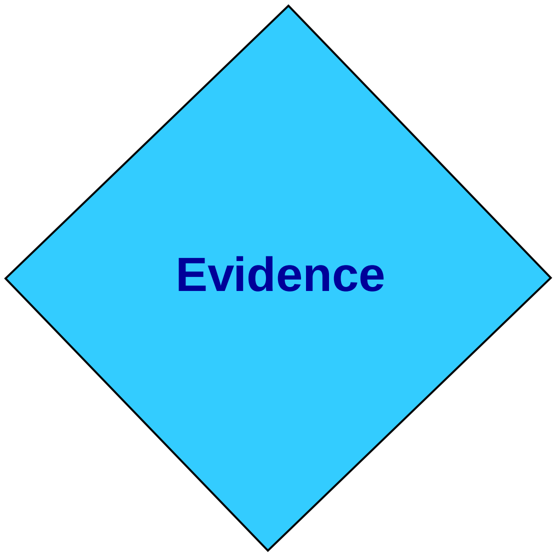
"Good sense is, of all things among men, the most equally distributed; for every one thinks himself so abundantly provided with it, that those even who are the most difficult to satisfy in everything else, do not usually desire a larger measure of this quality than they already possess."

Discourse on the method of rightly conducting the reason and seeking truth in the sciences
(Descartes, May 1637)

Reductionist approach

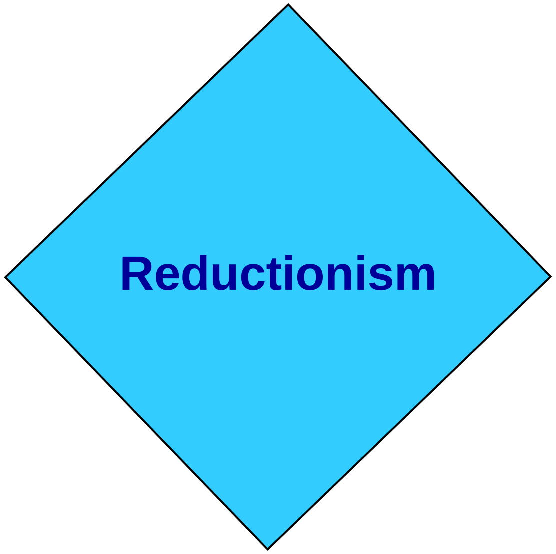


Reductionist approach



The first was never to accept anything for true which I did not clearly know to be such; that is to say, carefully to avoid precipitancy and prejudice, and to comprise nothing more in my judgment than what was presented to my mind so clearly and distinctly as to exclude all ground of doubt.

Reductionist approach



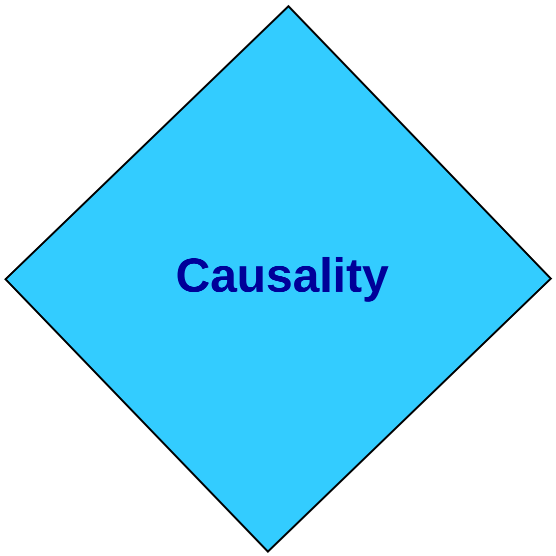
The second, to divide each of the difficulties under examination into as many parts as possible, and as might be necessary for its adequate solution.

Reductionist approach

This notion is the foundation for the engineering of large systems – essentially, design a system so that it is composed of discrete parts which, because they are smaller, are easier to understand and construct, define interfaces that allow these parts to work together, build the parts of the system then integrate these to create the desired system.

Most researchers in software engineering have taken a reductionist perspective

Reductionist approach

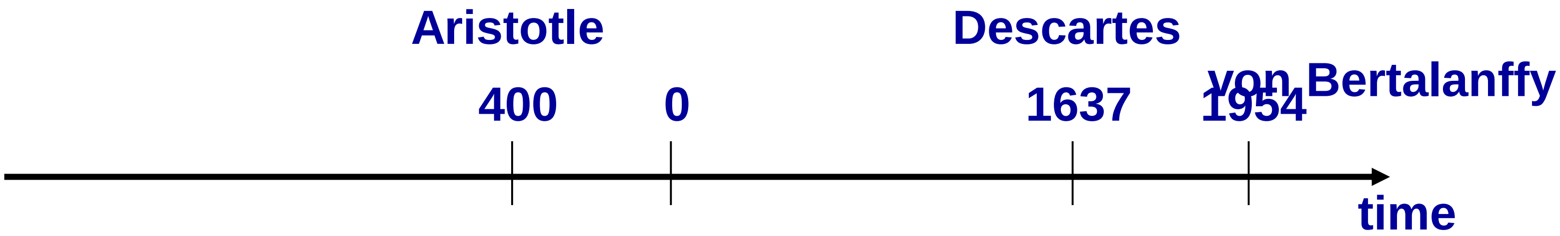


The third, to conduct my thoughts in such order that, by commencing with objects the simplest and easiest to know, I might ascend by little and little, and, as it were, step by step, to the knowledge of the more complex; assigning in thought a certain order even to those objects which in their own nature do not stand in a relation of antecedence and sequence.

Reductionist approach

The fourth and last, in every case to make enumerations so complete, and reviews so general, that I might be assured that nothing was omitted.

From Theology to System theory



Aristotle	Teleology (systems have a purpose)
Descartes	Reductionism
von Bertalanffy	General Systems Theory

System theory

- **Systems theory is the interdisciplinary study of systems ➔ the goal of elucidating principles that can be applied to all types of systems at all nesting levels in all fields of research**

- **The term does not yet have a well-established, precise meaning, but systems theory can reasonably be considered a specialization of systems thinking, a generalization of systems science, a systems approach.**

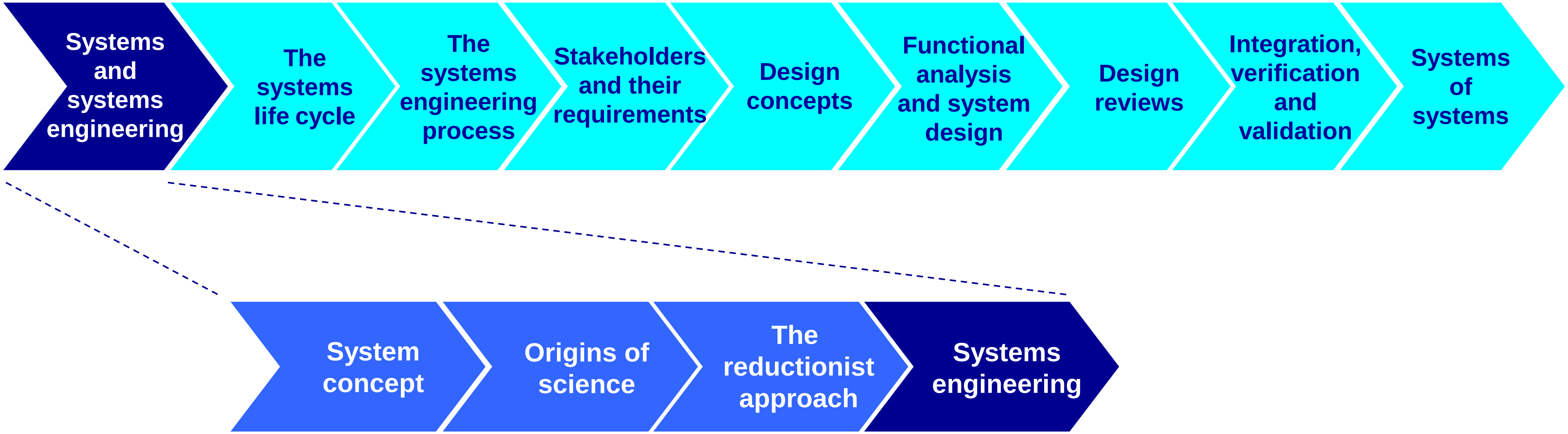
- **The term originates from Bertalanffy's general system theory (GST)**

Systems theories are an attempt to conceptualizing systems, developed upon the need to deal with complexity.

Reductionist approach

Being all four precepts important, two of them that we have inherited from Descartes still play a critical role today:

- **Seek evidence**
- **Be exhaustive in the analyses performed**
- **Never get things granted**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The VASA disaster

The VASA disaster

[redacted]

The VASA disaster

- Early in the XVII Century Europe was immersed in the Thirty Years War and Sweden was trying to consolidate its power in the Baltic Sea.

- In 1620 some 100 small ships integrated the. Between 1620 and 1625 Sweden launched 25 new ships but at the same time lost 12 between accidents and the war with Poland. Sweden needed more ships.

- King Gustav II Adolf of Sweden used to say that ‘the welfare of our Kingdom depends on God and, in second place, on our Navy’.

The VASA disaster

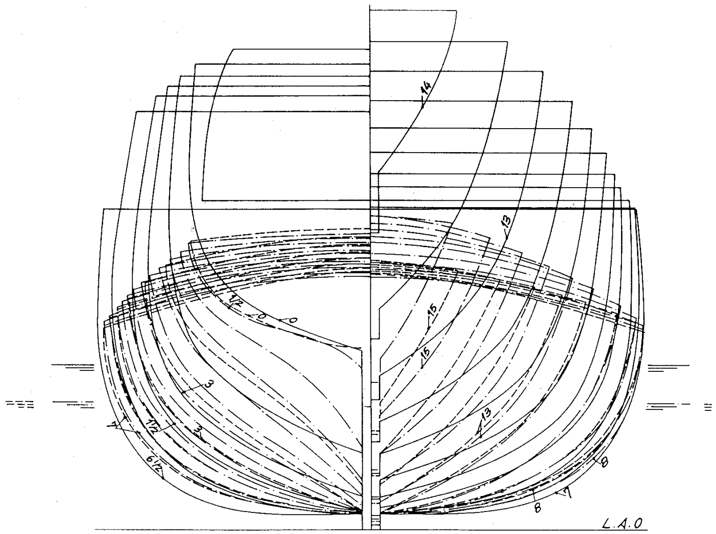
On January 16, 1625, the King Gustav II Adolf ordered Vice-Admiral Fleming to contract with the Hybertsson brothers (Henrik and Arend), of Dutch origin but established in Stockholm, the construction of four large warships, two with keel of 108 feet and the other two with keel of 135 feet. Over 1.000 oak tress were cut down from the royal forests, following the estimates made of needed wood.

The VASA disaster

- September 20, 1625: the Swedish Navy lost 10 ships in a storm. The King then ordered that the 108-feet ships (the VASA and the Three Crowns) be constructed first so that they could rapidly be commissioned.
- November 30: the King requested that the keel of the ships be enlarged up to 120 feet, so that the ships could carry more guns (32 24-pound cannons in a single closed deck). The constructor Heinrik Hybertsson estimated he had sufficient wood for one ship of 111-foot keel and for another one of 135-foot keel. Work should commence on the 111-foot ship, the VASA.
- King Gustav II Adolf learned later that Denmark was building a large warship with two enclosed decks, and he then ordered that the VASA be enlarged to 135 feet and that it also had a second deck for guns.

The VASA disaster

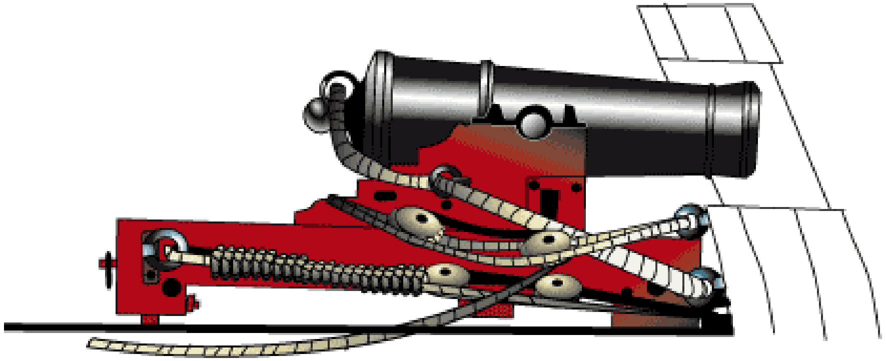
- As the keel had already been laid down, in order to have two decks with cannons it was necessary to increase the breadth of the hull in its upper part, which meant raising the center of gravity of the ship.
- The number and caliber of the guns was modified several times, always increased, which further complicated the problem of the position of the center of gravity and consequently the stability of the VASA.



The VASA disaster

- From the initially planned 32 24-pound guns the number was brought uo to 36 and 24 12-pound guns were added, plus 8 48-pound mortars and 10 small guns. A further revision meant plans for arming the ship with 30 24-pound guns in the lower deck and with 30 12-pound guns in the upper one.

- Finally, the King decided that each deck should be fitted with 32 24-pound guns, plus some small-caliber guns; the fact that all the main guns were of the same caliber should facilitate the logistics of the ammunition, the powder charges and the rest of elements needed for the use of the guns.



The VASA disaster

The narrow keel prevented the placing of all the ballast deemed necessary, although it was a most rough estimate as the Hybertsson brothers have never constructed a two-deck ship and did not have the knowledge and the tools required for performing stability predictions.

The VASA disaster

Two years and a half later construction of the VASA was finalized. Most simple stability tests were run in front of Vice-Admiral Fleming, with sailors moving rapidly from port to starboard, and back. The tests were interrupted upon the worrying lists developed by the ship.

The VASA disaster

- On August, 10, 1628 the VASA set sails on its maiden voyage. After sailing less than one nautical mile hte ship listed to port and capsized off Beckholmen island.

- Approximately one third of the 150-strong crew drowned.

The VASA disaster

http://www.youtube.com/watch?v=7Ow7Bk-PmCU

Vasa case study

- What went Wrong ?
- Why it went wrong ?
- Who were the responsibles ?
- Others comments ?

The VASA disaster

Who was responsible for the disaster?
They all were, to some extent:

- **The King Gustav II Adolf was anxious to have new warships with many heavy guns. He changed repeatedly the requirements and pushed for a rapid construction of the ships.**

- **The Vice-Admiral Fleming could have stopped the ship after the worrying stability tests. At least he could have waited for the King, who was at the time fighting in Prusia. Moreover, he did not express any concerns with the continuous changes of requirements.**

- **The constructor Henrik Hybertsson did not indicate the risks associated with the continuous changes in the requirements. His sudden passing away half-way in the construction of the ship only made things worse.**

The VASA disaster

- The captain Söfring Hansson was aware of the **stability problems** and yet he decided to sail with the loopholes open, which eventually facilitated the entering of water.

- Hein Jacobsson took over after the demise of Henrik Hybertsson. He did not know that a stability test had been conducted. Apart from the result of the test, it is difficult to justify that he was not aware of the performance test being the program manager at that time.

The VASA disaster

The official investigation concluded that the disaster was due to a series of misfortunes and to the limited technical knowledge.

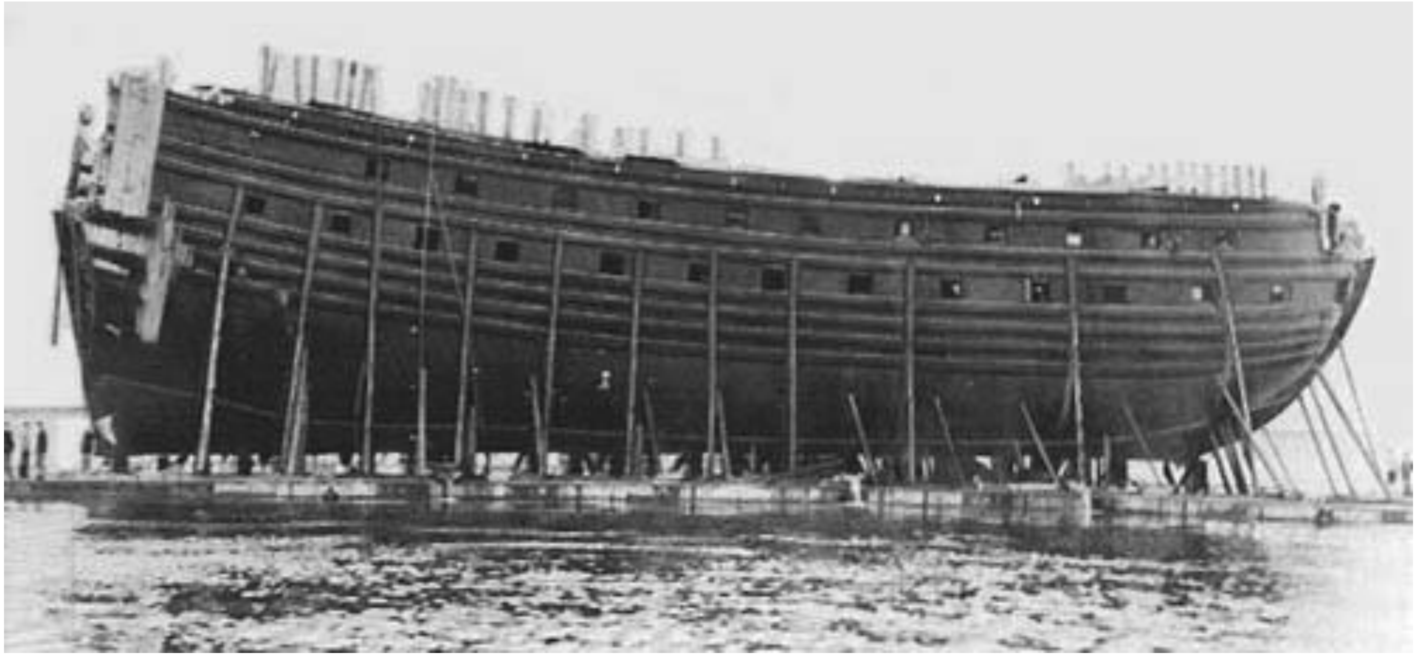
Nobody was formally held responsible.

The VASA disaster

The capital errors in the VASA project:

1. **Initial requirements incomplete and fuzzy.**
2. **Continuous changes (‘creeping’) of requirements.**
3. **Excessive calendar pressure.**
4. **Lack of a documented project plan.**
5. **Inappropriate definition of responsibilities.**
6. **Too many innovations and poor risk management.**
7. **Lack of knowledge and scientific methods.**
8. **Lack of holistic view.**
9. **Lack of professional ethics.**

The VASA disaster



The VASA after being re-floated in 1961, four years after the marine archeologist Anders Franzen found it.

The VASA disaster

The VASA in the Vasamuseet in Stockholm.

The VASA disaster

- **Errors such as those of the VASA project are unfortunately much more frequent than what we think, although their consequences are not always so evident or so dramatic!**

What other typical errors are made today?

Others example ?

Others Cases?

May 31, 2009: Air France (AF) flight AF447 Rio de Janeiro-Galeão to Paris-Charles de Gaulle Airport (216 passengers and 12 crew members.)

PROXIMATE CAUSES

- **Cyclical series of erroneous inputs based on a cascade of prompts from aircraft systems**
- **Failure to identify unreliable airspeed indication**
- **Failure to identify the approach to stall or fully stalled condition**
- **Inability to apply appropriate stall recovery controls**

http://nsc.nasa.gov/SFCS/Index/SortBydate/Descending/Page4/

Others Cases?

May 31, 2009: Air France (AF) flight AF447 Rio de Janeiro-Galeão to Paris-Charles de Gaulle Airport (216 passengers and 12 crew members.)

UNDERLYING ISSUES

- Design of aircraft systems
- Pilot and copilot training

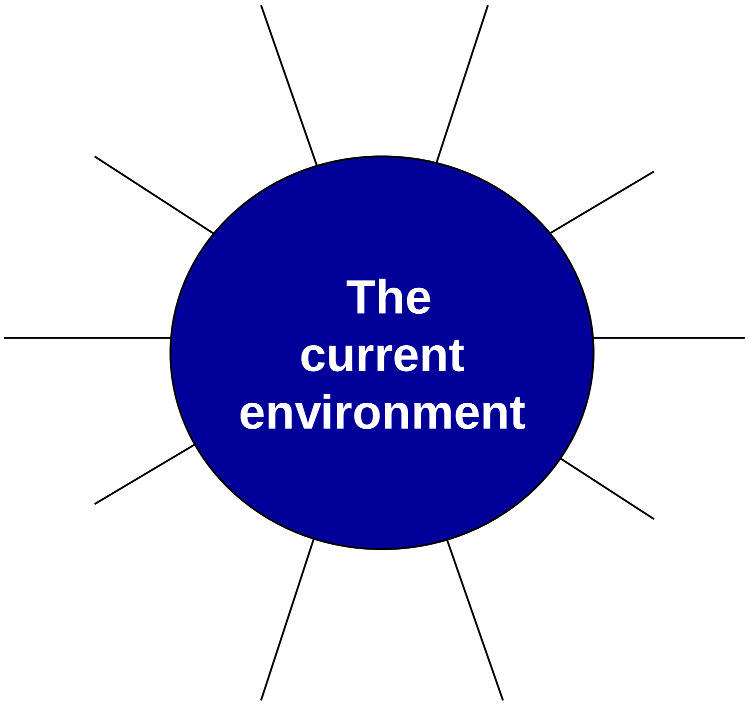
AFTERMATH

- Changes to training and aircraft systems by Airbus, Air France prior to final report
- Improvements called for in oversight inspection practices, inflight transmission of aircraft performance and location data, air traffic control flight following, search and rescue procedures, and aircraft salvage

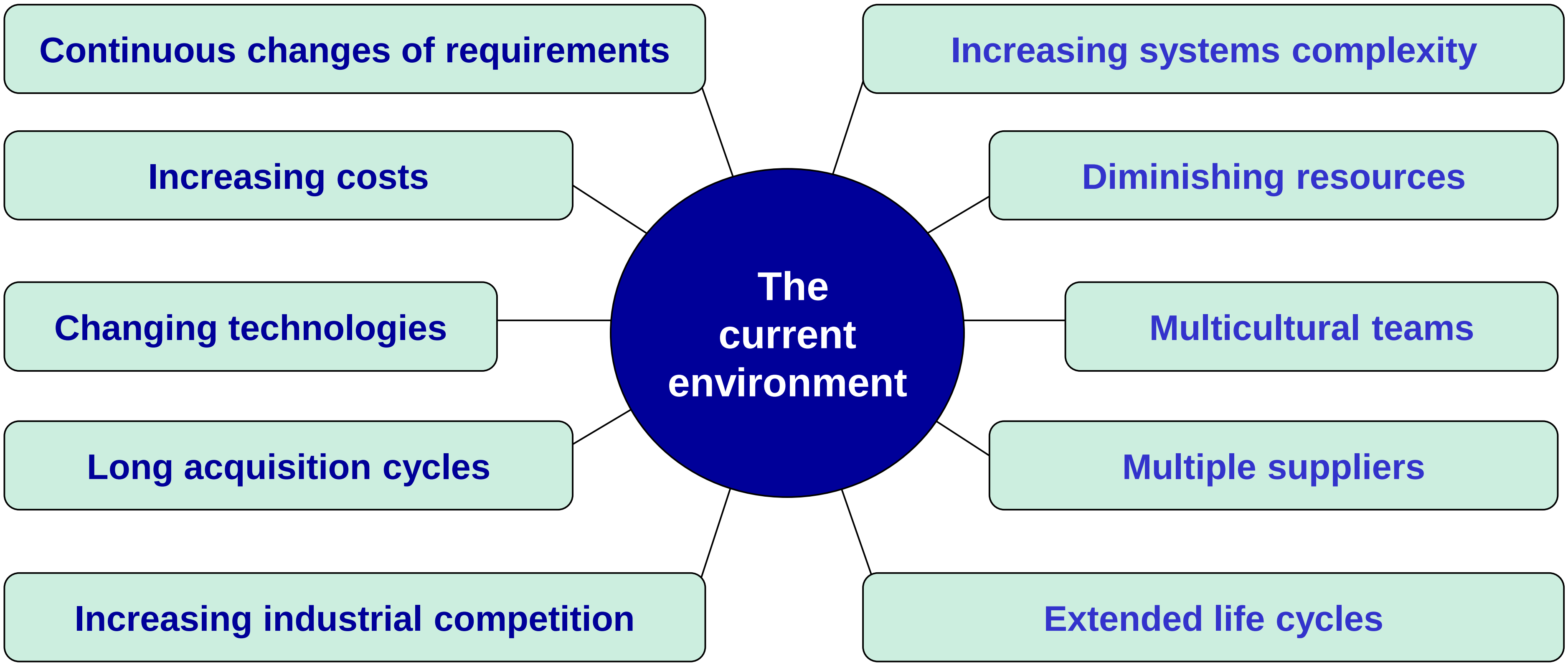
http://nsc.nasa.gov/SFCS/Index/SortBydate/Descending/Page4/

Others disasters in mind?
Let's share ---

The current environment



The current environment



Systems engineering

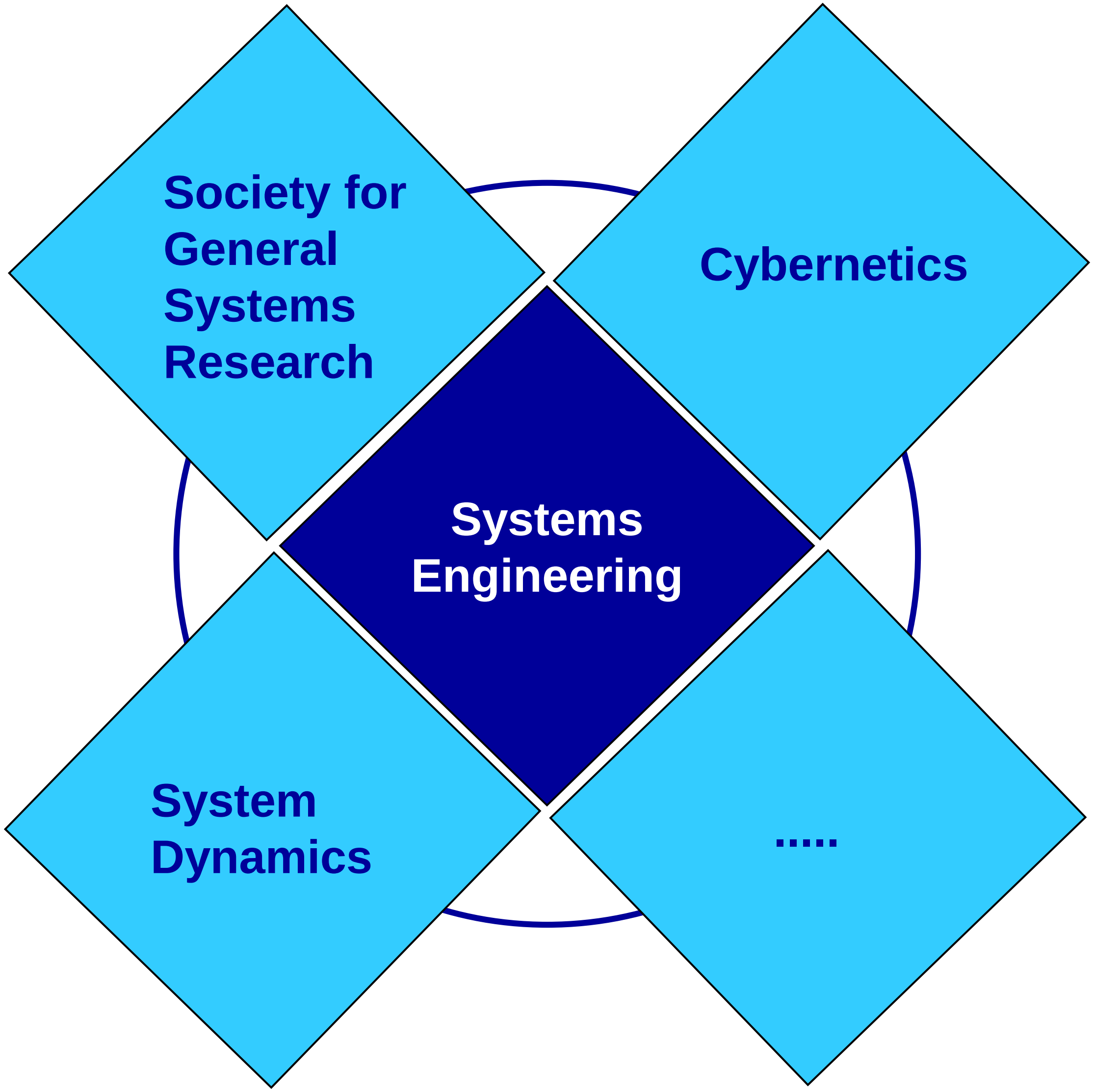
- ✓ **Probably the first formal attempt to teach systems engineering was made in 1950 at the Massachusetts Institute of Technology by G. W. Gilman, then Director of Systems Engineering at Bell Laboratories, Inc.**

- ✓ **Harry H. Goode and Robert E. Machol, professors at the University of Michigan, published in 1957 *Systems Engineering: An Introduction to the Design of Large-Scale Systems*. Their book was one of the first authoritative texts in systems engineering, addressing its philosophy and methodology.**

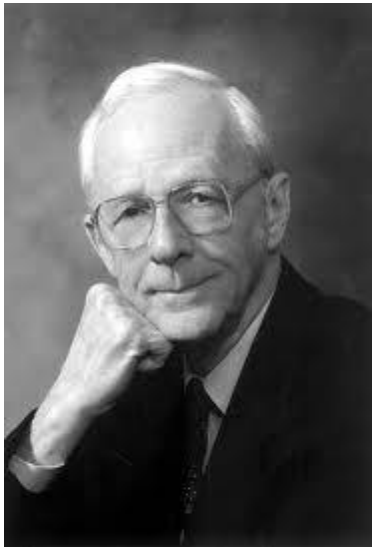
Systems engineering

- ✓ In the 1940s Bell Laboratories was the first to use the term 'systems engineering'.
- ✓ The study in 1945 of anti-aircraft guided missile systems was regarded as a milestone in systems engineering precisely because it was comprehensive enough to address a whole system.
- ✓ Systems engineering was born with analyses of ends and definition of objectives as integral parts of the engineering effort.

Systems Engineering

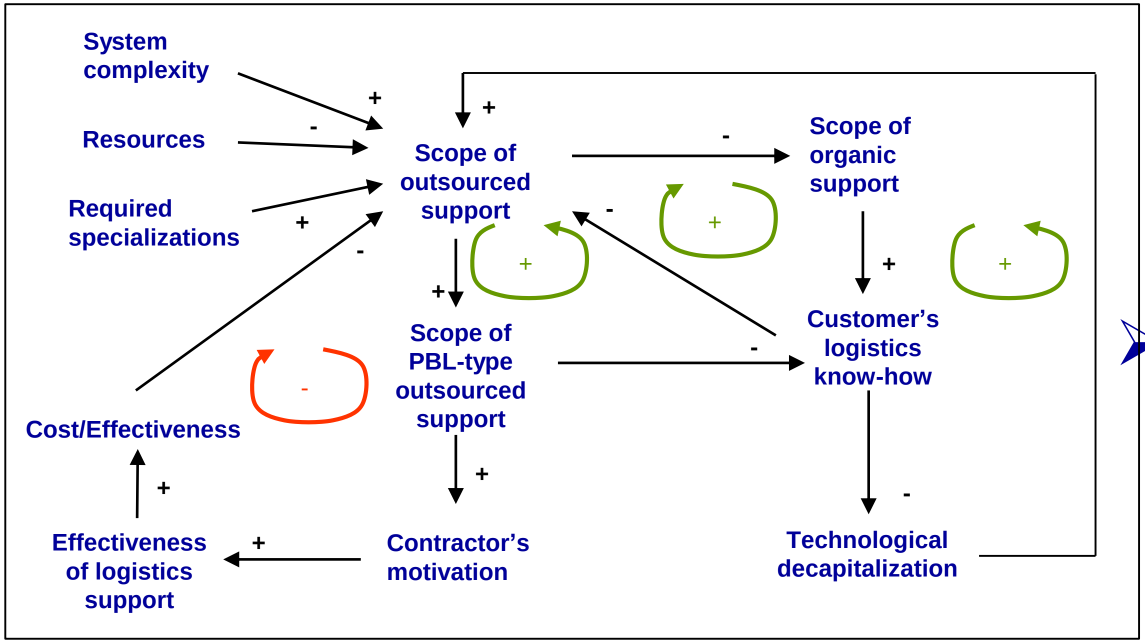


System dynamics



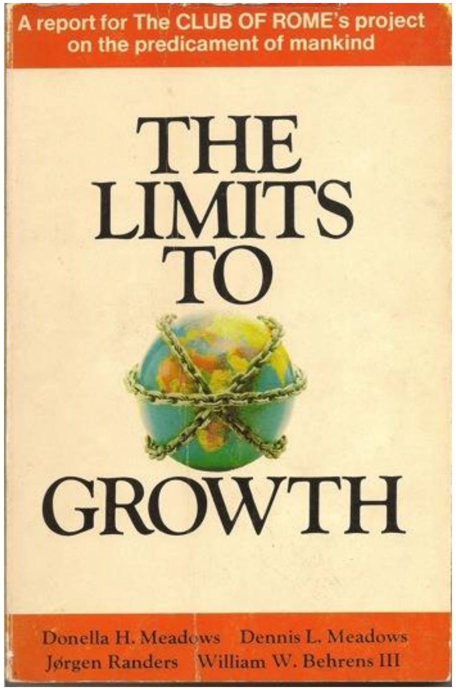
- In the 50s some GE appliance factories were exhibiting many problems. Prof. Forrester of MIT was hired to help, and first he said he needed to diagnose the situation.
- Forrester developed the technique known as industrial dynamics to model the behavior of those factories, analyzing cause-and-effect relationships.
- Eventually he discovered that the delays in the flow of information were responsible for the issues suffered by the factories.

System dynamics



- Industrial dynamics was renamed as **Urban Dynamics** after its use to plan urban developments.
- Eventually it was called **System Dynamics**, in light of its power to gain understanding on the more complex systems and help in their design.

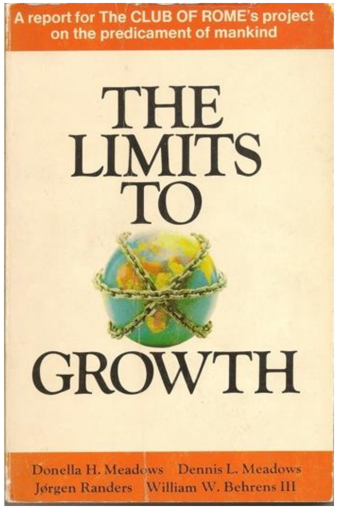
System dynamics



- **An example of the power of systems dynamics is the study performed of the planet Earth as a whole using system dynamics (first report asked by the Club of Rome).**

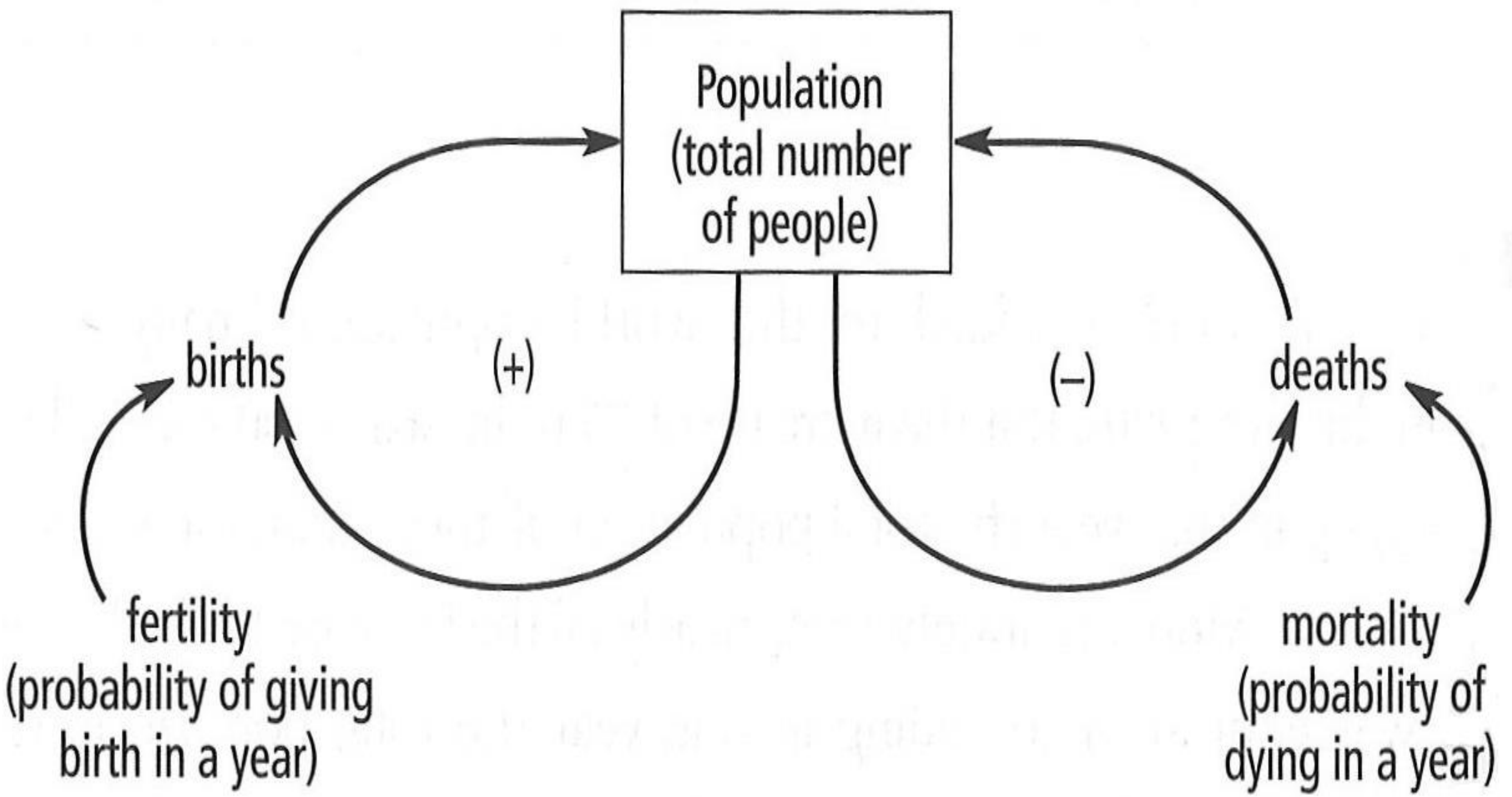
Limits to Growth (1972)

- Jay W Forrester
  - **Systems Dynamics Group**
  - Sloan School of Management
  - MIT
- Dennis Meadows
  - analyze long term causes and consequences of growth in population and material economy

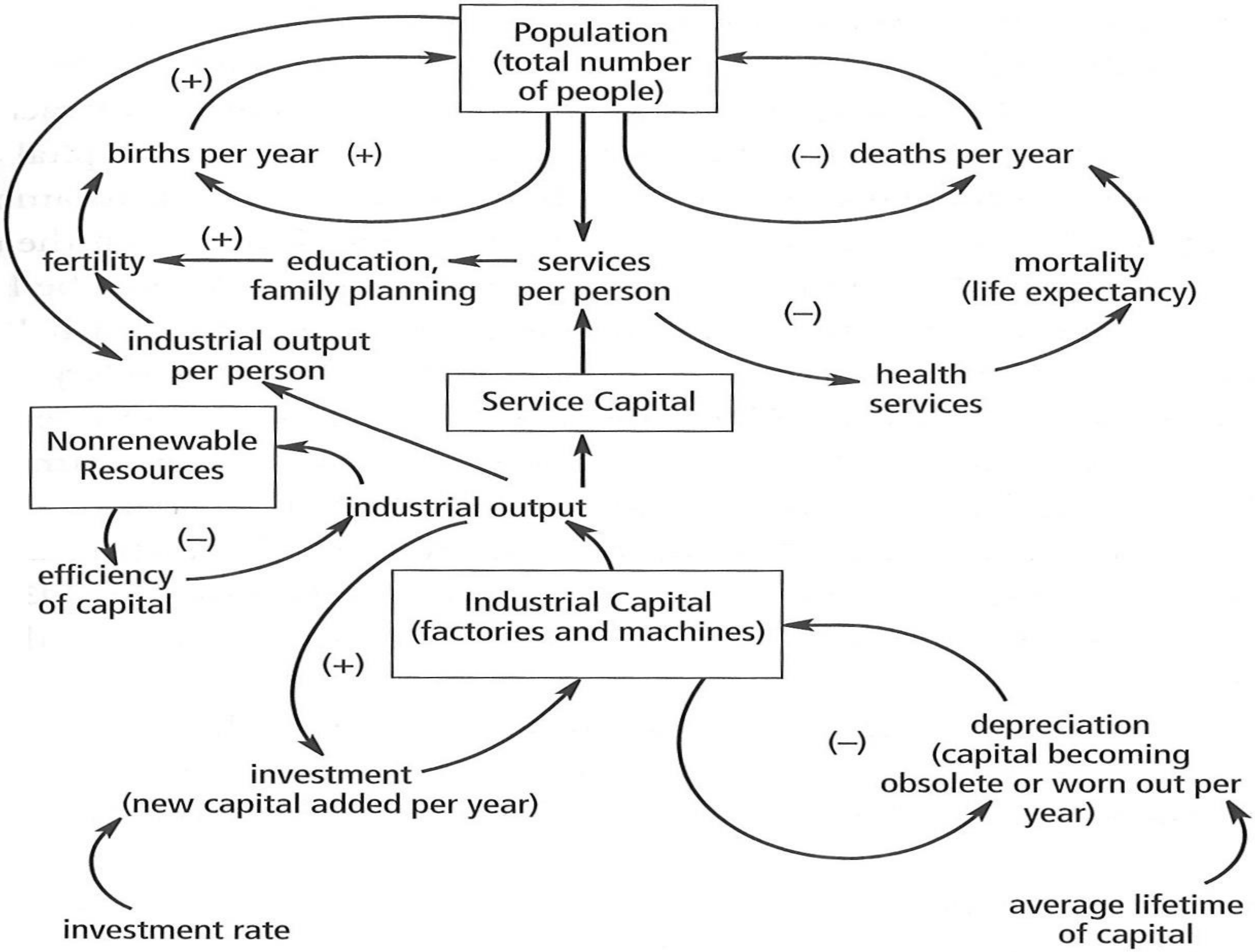


➢**The result was 'The Limits to Growth', which highlights the importance of the global view. It helped coin the term 'sustainable development'.**

System Dynamics

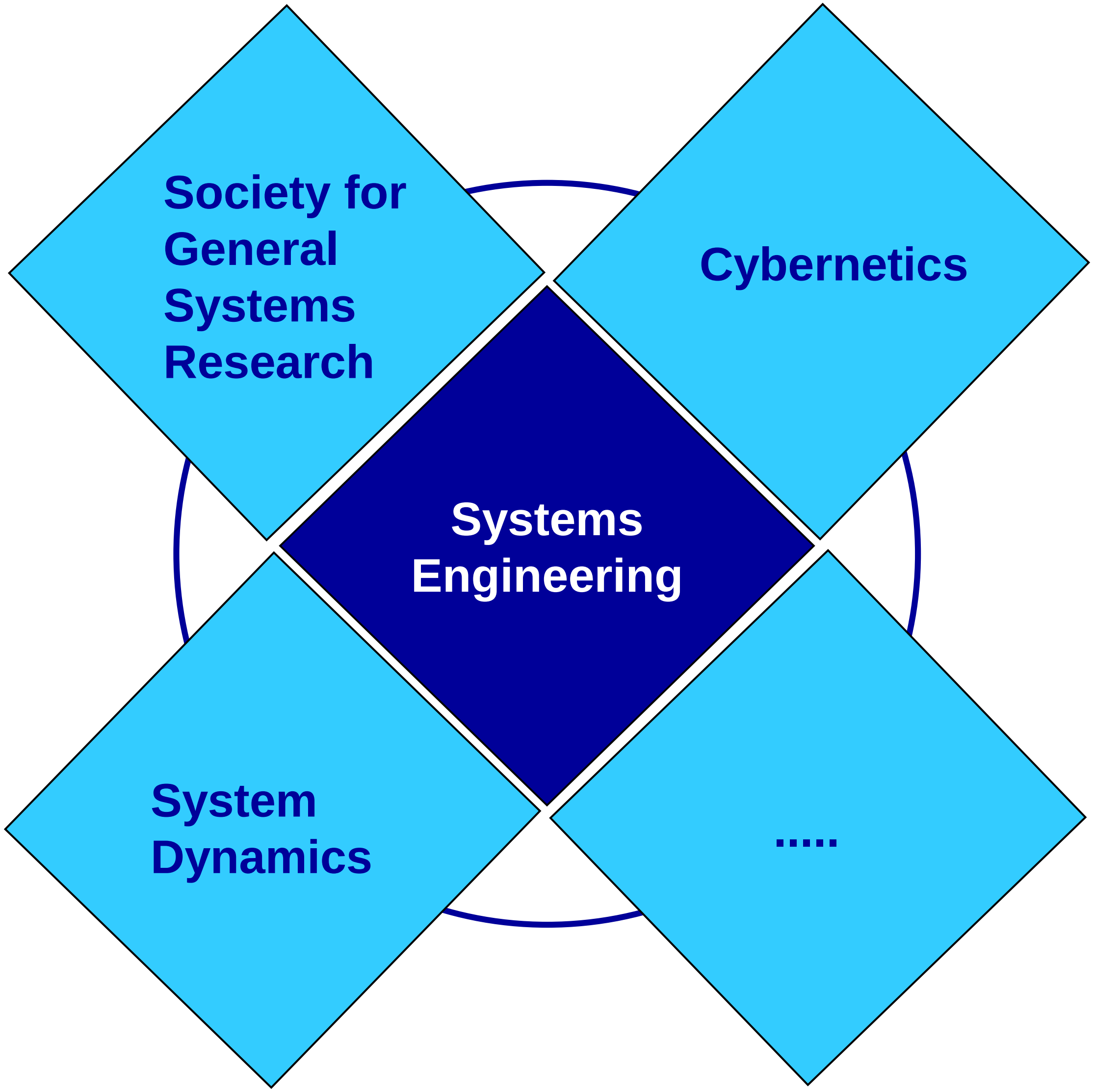


Population and Industrial Capital



D Meadows et al

Systems engineering



Society for General Systems Research

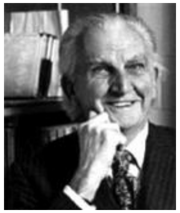
In the first half of the XX Century a biologist and philosopher, Ludwig von Bertalannfy, noted that modern science was characterized by a growing specialization, which lead to more and more disciplines, less and less connected among them, and that at the same time similar problems and concepts were evolving in totally different fields, independently from each other.

Society for General Systems Research

Restrictive hypothesis of the reductionist approach

- **Interactions among system components are either non-existent or weak enough so as to be neglected.**
- **The relationships that describe the behavior of the components of the system are lineal.**

Society for General Systems Research


- Together with Boulding, Rapoport, Margaret Mead, William Ross Ashby, Gregory Bateson and others, von Bertalanffy conceived in the Center for Advanced Studies in the Behavioral Sciences a 'Society for the General Systems Theory', finally established in 1954 in a meeting of the American Association for the Advancement of Science.

- The name eventually adopted was the less pretentious 'Society for General Systems Research'.



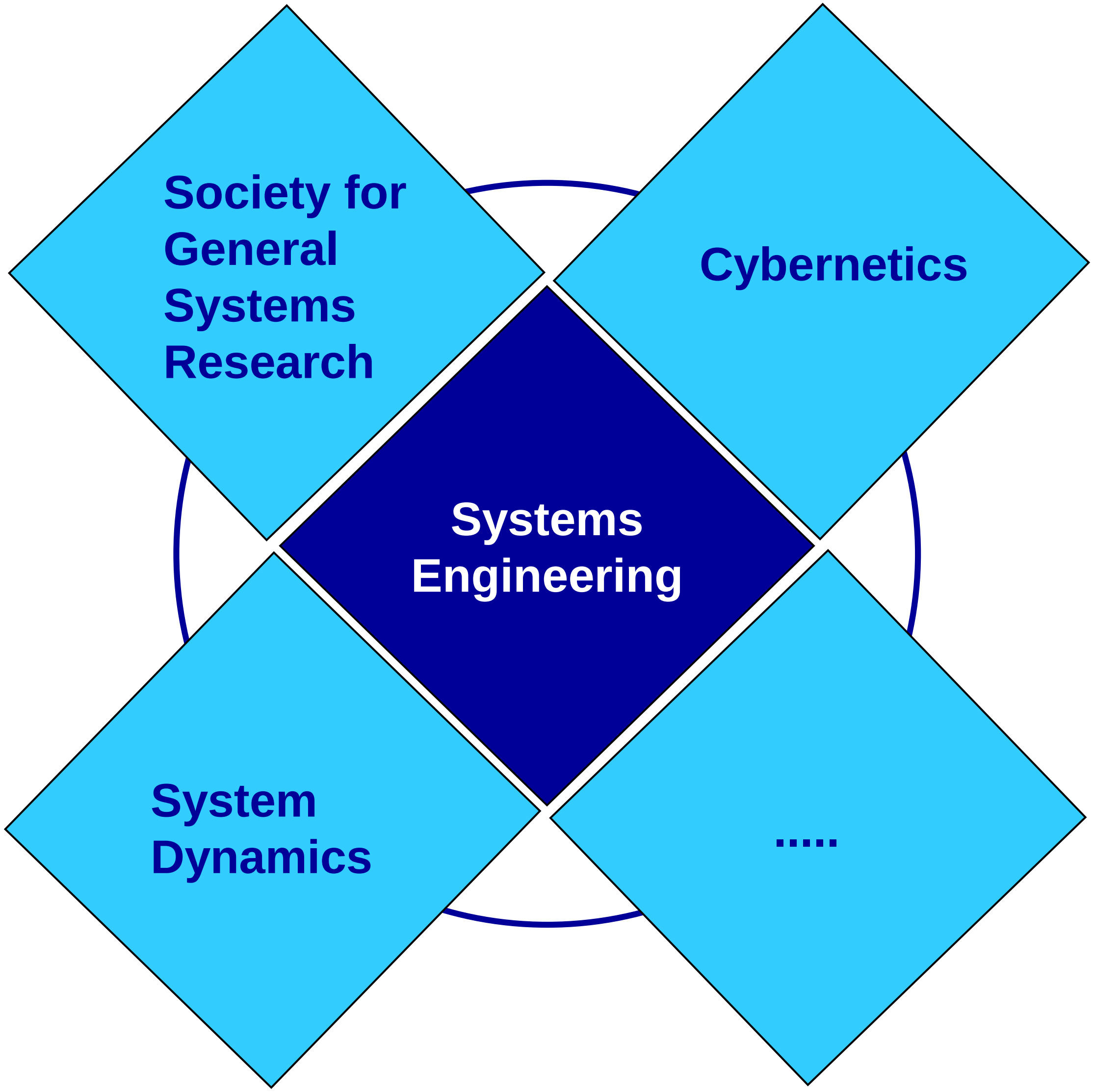
Society for General Systems Research

➔ ➔ International Society for the Systems Science.

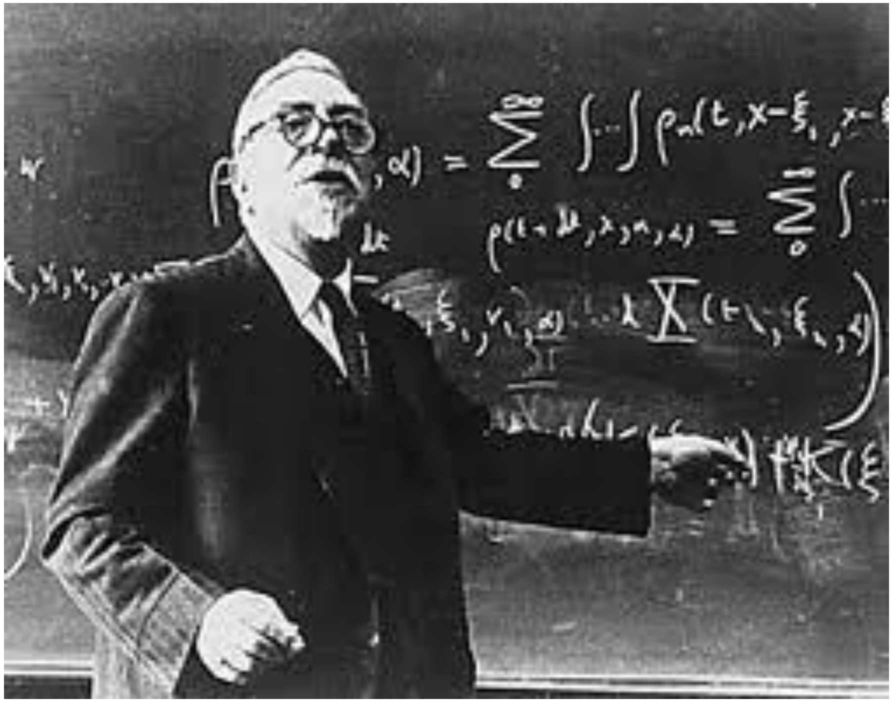
"to promote the development of conceptual frameworks based on general system theory, as well as their implementation in practice. It further seeks to encourage research and facilitate communication between and among scientists and professionals from various disciplines and professions at local, regional, national, and international levels

http://www.isss.org/world/

Systems engineering



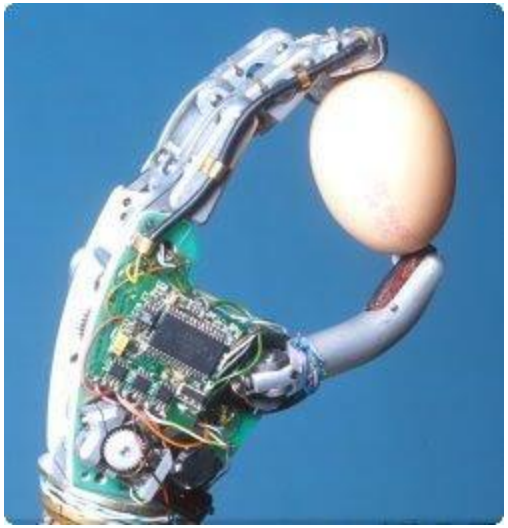
Cybernetics



- In the late 40s Norbert Wiener wrote Cybernetics, on control and commnication in the animal and the machine.

- Wiener showed the importance of feedback in the attainment of goals.

Cybernetics



"Cybernetics" comes from a Greek word meaning "the art of steering".

Cybernetics is about having a goal and taking action to achieve that goal.

Knowing whether you have reached your goal (or at least are getting closer to it) requires "feedback",
a concept that comes from cybernetics.

Human Body – Feedback Leading to System Regulation

The human body is one of the richest sources of examples of feedback that leads to the regulation of a system. For example, when your stomach is empty, information is passed to your brain.

www.gwu.edu/~asc/slideshow/HistoryCybernetics_English.ppt

Feedback – Corrective Action

When you have taken corrective action, by eating, your brain is similarly notified that your stomach is satisfied.

www.gwu.edu/~asc/slideshow/HistoryCybernetics_English.ppt

Feedback – Hunger Example

In a few hours, the process starts all over again. This feedback loop continues throughout our lives.

Stomach Feels Empty

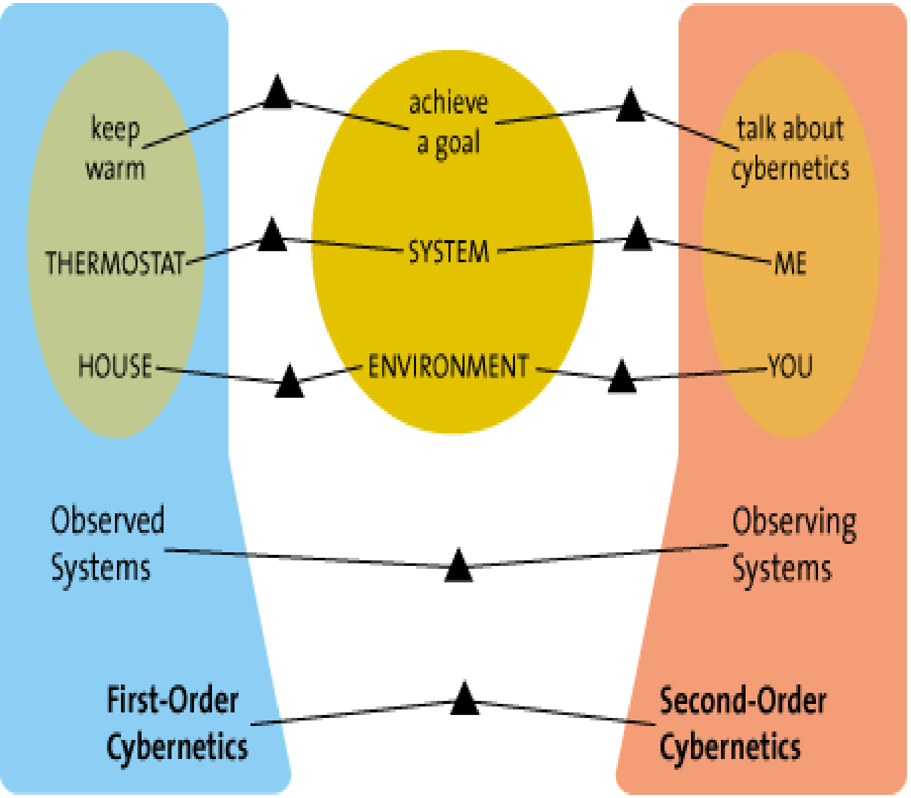
Time

Stomach Feels Full

Person Eats

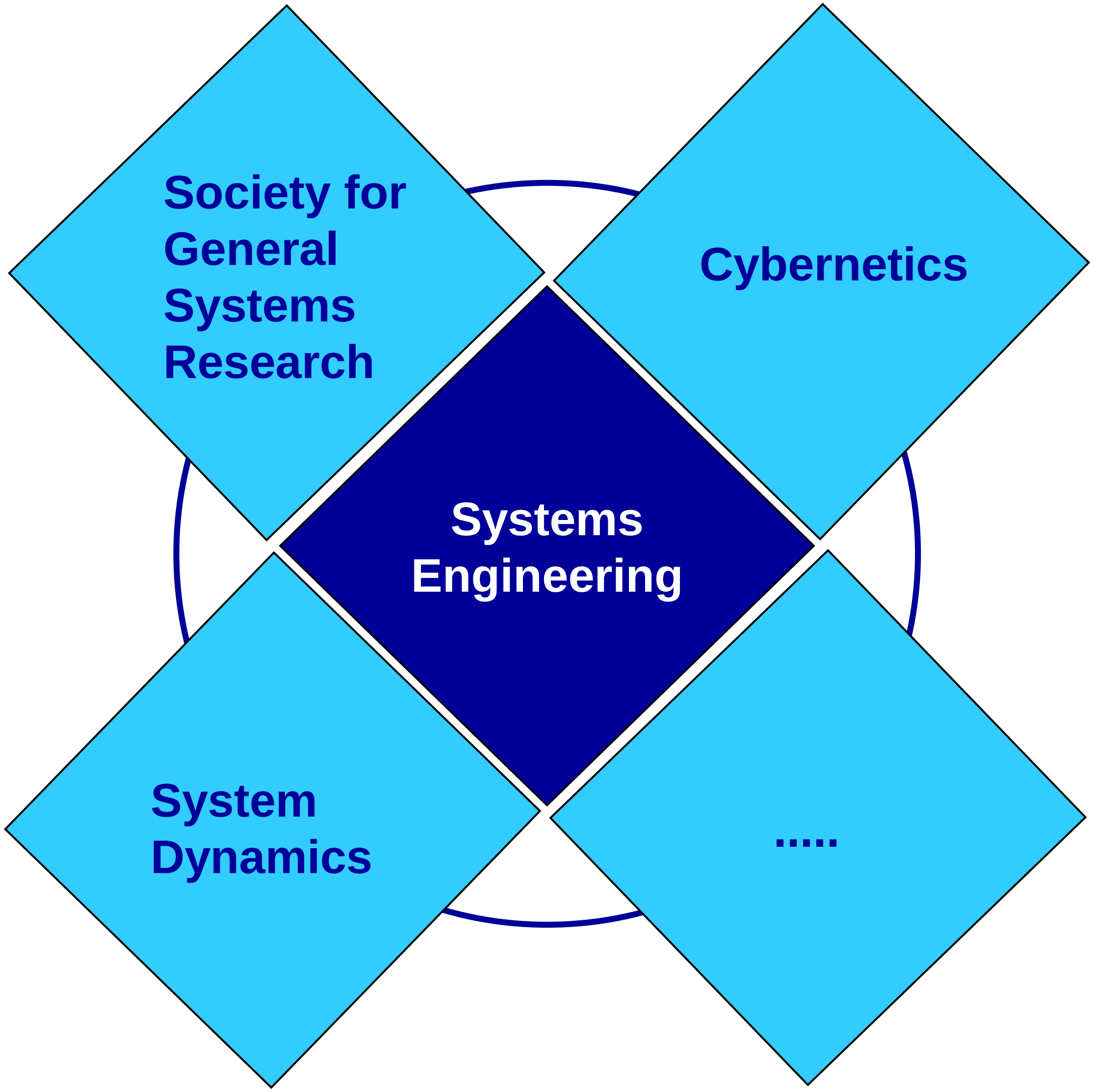
www.gwu.edu/~asc/slideshow/HistoryCybernetics_English.ppt

Cybernetics Studies



Studies in cybernetics provide a means for examining the design and function of any system, including social systems such as business management and organizational learning, including for the purpose of making them more efficient and effective

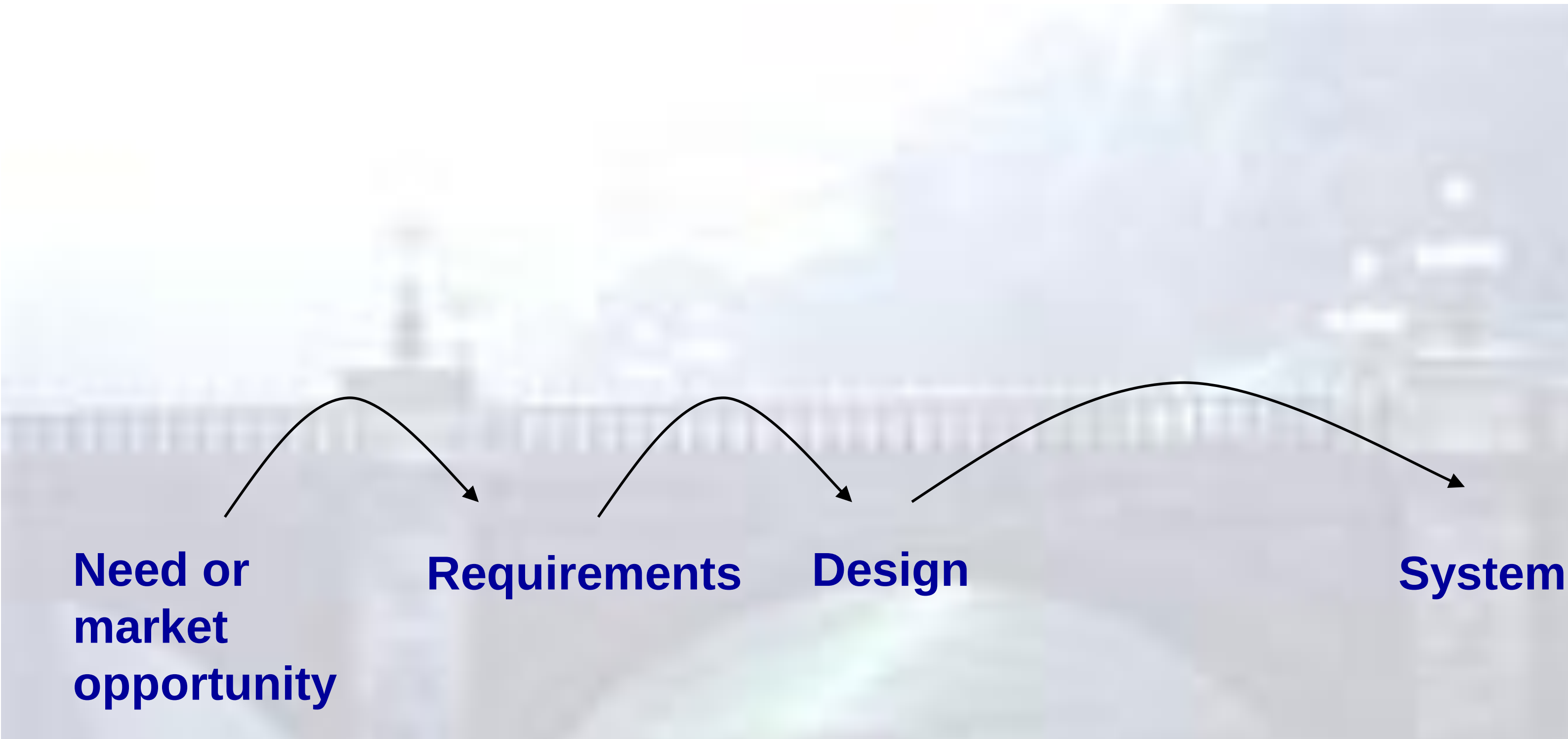
Systems engineering



Systems engineering

There are many definitions of systems engineering, although all have in common the transformation of the analysis of a need or opportunity into requirements, the holistic view (integration of disciplines and top-down processes), the consideration of the entire life cycle and the need for the system to effectively and efficiently fulfill its goals throughout the complete life cycle.

Systems engineering



Systems engineering is the *bridge* between the identification of needs or market opportunities and the acquisition of systems that fulfill them effectively and efficiently.

Systems engineering

Systems engineering is an approach to translate approved operational needs into operationally suitable blocks of systems. The approach shall consist of a top-down, iterative process of requirements analysis, functional analysis and allocation, design synthesis and verification, and system analysis and control.

Systems engineering

Systems Engineering and Integration (SE&I) is a disciplined approach for the definition, implementation, integration and operations of a system (product or service). Emphasis is on the satisfaction of stakeholder functional, physical and operational performance requirements in the intended use environments over its planned life cycle within cost and schedule constraints.

Systems engineering

INCOSE

International Council on Systems Engineering

Systems engineering is an engineering discipline whose responsibility is to create and execute an interdisciplinary process to ensure that the customer and stakeholder's needs are satisfied in a high-quality, trustworthy, and cost and schedule efficient manner throughout a system's entire life cycle.

http://www.incose.org/

Systems engineering

The essence of systems engineeering is the global or holistic view!

INCOSE®
International Council on Systems Engineering

The International Council on Systems Engineering (INCOSE) is a not-for-profit membership organization founded in 1990. Our mission is to share, promote and advance the best of systems engineering from across the globe for the benefit of humanity and the planet.

Int'l Symposium | Systems Engineering | INSIGHT | i pub | INCOSE SEP | INCOSE FOUNDATION | LinkedIn | twitter

Current News

Do you have 30 minutes to take a PhD survey? (26 Sep 12)
Clement Smartt, PhD candidate at University of Texas at Arlington requests your help - consider completing this survey on systems engineering to support proposal management for contract-based organizations.

CrossTalk October 2012 Article (18 Sep 12)
Read the article written by Bill Miller, Deputy Technical Director.

Systems Engineering Certification Tutorial Webinar (17 Sep 12)
Beginning Thursday, October 4th 2012 and running through March 2013, this course helps in preparation for SE certification exam.

Systems Engineering Fundamentals Tutorial Webinar (17 Sep 12)
Beginning Wednesday, October 3rd 2012 and running through December 2012, this course teaches fundamentals of SE.

INCOSE Foundation planning a fundraising trip to NYC after IS 2013 (16 Aug 12)
Come join us after IS 2013 in Philadelphia.

NAFEMS and INCOSE announce a collaboration to accelerate innovation for engineering simulation and model based systems engineering (16 Aug 12)
This collaboration includes the implementation of a joint cross organizational working group on Systems Modeling & Simulation.

Not too early to begin planning for IS2013 (08 Aug 12)
The 23rd Annual INCOSE International Symposium returns to USA - paper, panel and tutorial deadline is 8th November 2012.

INCOSE Systems Engineering Journal Editor-in-Chief Search (31 Jul 12)
The Board of Directors of the International Council on Systems Engineering (INCOSE) is soliciting nominations for Editor-in-Chief of the journal Systems Engineering.

PMI, INCOSE and Lean Advancement Initiative (LAI) at MIT Partner to Find Best Practices for Delivering Successful Programs (12 Jun 12)
"Lean Enablers for Managing Engineering Programs" Identifies Best Practices that Effective Teams and Organizations Can Use to Overcome Challenges.

INCOSE BOD releases key messages from 2012Q2 meeting (30 May 12)

Upcoming Events

October 01 - 04, 2012
MORS Affordability Workshop

October 12 - 13, 2012
6th Annual INCOSE Great Lakes Regional Conference

October 23 - 25, 2012
ICSSEA 2012 24th International Conference

November 01 - 02, 2012
Fourth Annual Medical Device Connectivity Conference and Exhibition

November 07 - 08, 2012
ASEC2012 - "Building a Better Future"

December 12 - 14, 2012
3rd International CSDM - Early Registration Extended to 30 Sept.

January 26 - 27, 2013
INCOSE MBSE Workshop 2013

January 26 - 29, 2013
IW 2013

March 04 - 06, 2013
INCOSE IL2013

March 19 - 22, 2013
CSER 2013

April 29 - May 01, 2013
Systems Engineering and Test and Evaluation Conference - SETE2013

June 24 - 27, 2013
IS 2013 - Philadelphia

Members Only | Join INCOSE

Member Resources

Log in using your Connect account (your firstName.lastName) to access these INCOSE resources.

- INCOSE Connect
- Product Area
- i-Pub Publication Database
- INSIGHT Library
- SE Journal Online (Wiley)
- Discussion Forum
- Member Directory
- View / Update Member Record
- Reset Password

Quick Links

- What is Systems Engineering
- Technical Operations
- Working Groups
- SE Tool Database
- Academic Program Directory
- Job Bank
- My Chapter

Media Relations

BEST JOBS IN AMERICA ??(2009)
➔ TOP 50

Systems engineer	➔	45 %
Physician Assistant	➔	27%
College Professor	➔	23%

http://money.cnn.com/magazines/moneymag/bestjobs/2009/full_list/index.html

BEST JOBS IN AMERICA ??(2009) ➔ TOP 50

PHOTO: BRAD DECECCO

Anne O'Neil, a chief systems engineer at the N.Y.C. Transit Authority, is one of five female senior managers in a department of 1,500.

What they do: "big think" managers on large, complex projects,➔ Technical specifications

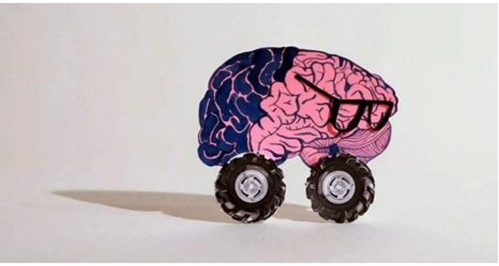
Why it's great: High Demand ➔ aerospace, defense industries➔ medical device makers to Xerox and BMW.

High Pay- Advancement - Creativity.

Drawbacks: Long hours, project deadlines, stress

http://money.cnn.com/magazines/moneymag/bestjobs/2009/full_list/index.html

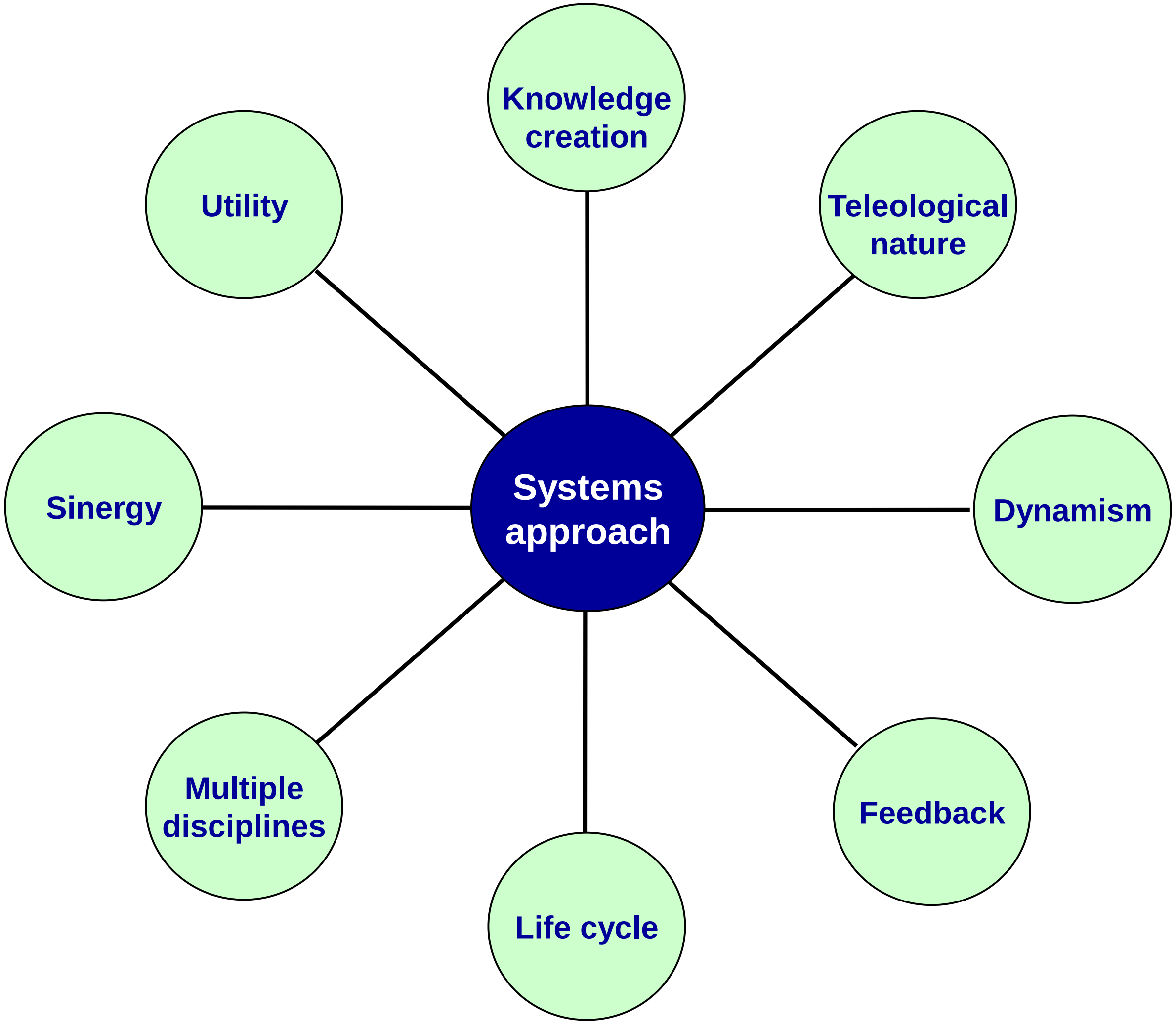
In summary let's see what Dassault systemes says



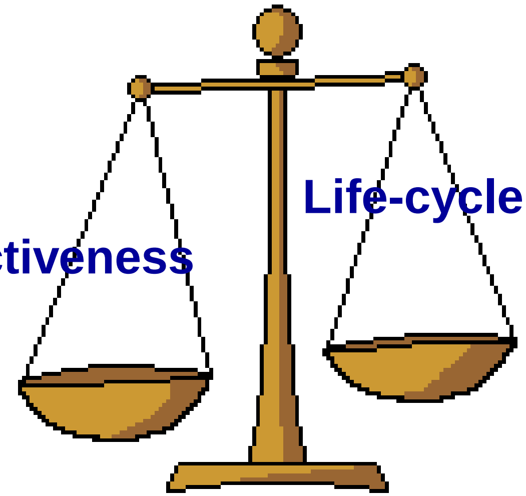
http://www.youtube.com/watch?v=JKUycuyGj7I&feature=player_embedded#!

http://perspectives.3ds.com/collaboration/c-level-systems-engineering/

The systems approach



Cost / Effectiveness



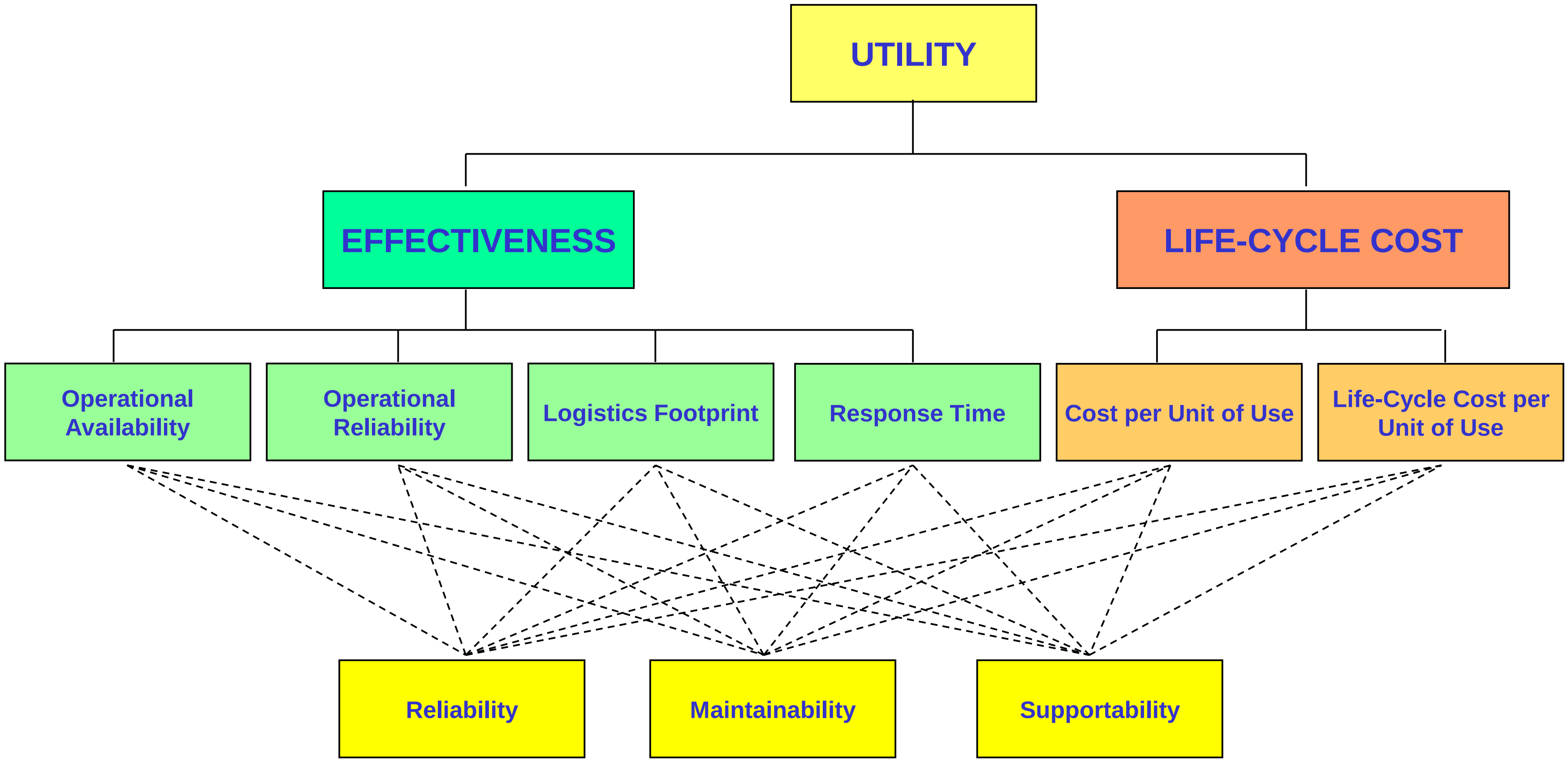
Life-cycle cost

Effectiveness

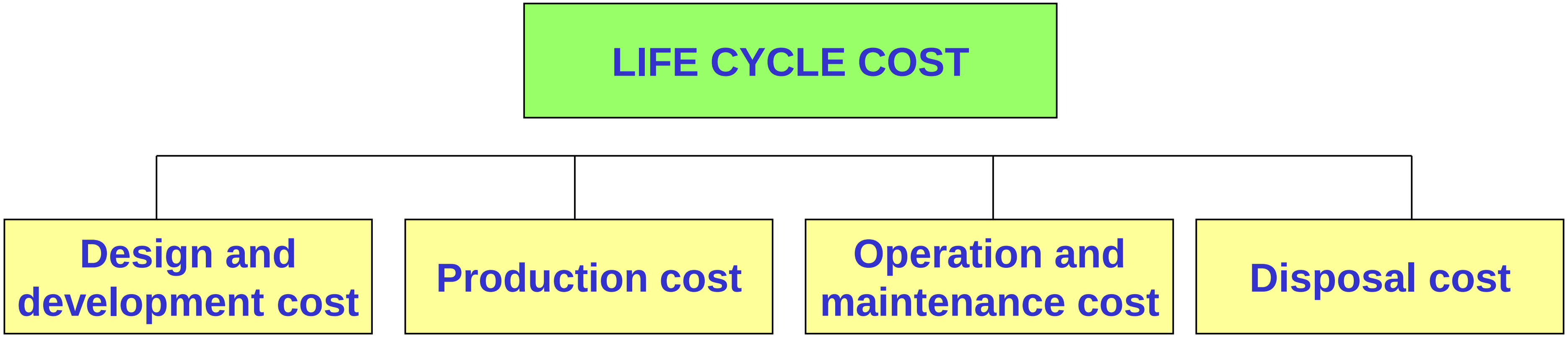
Extent to which the system fulfills the need of the user

Total cost borne by the user of the system throughout its life cycle

Cost / Effectiveness



Life-cycle cost



Design and development cost

- Management cost
- Research cost
- Design cost
- Test cost
- Documentation cost

Production cost

- Management cost
- Production investment cost
- Production cost
- Quality control cost
- Test cost
- Documentation cost
- Initial logistics support cost

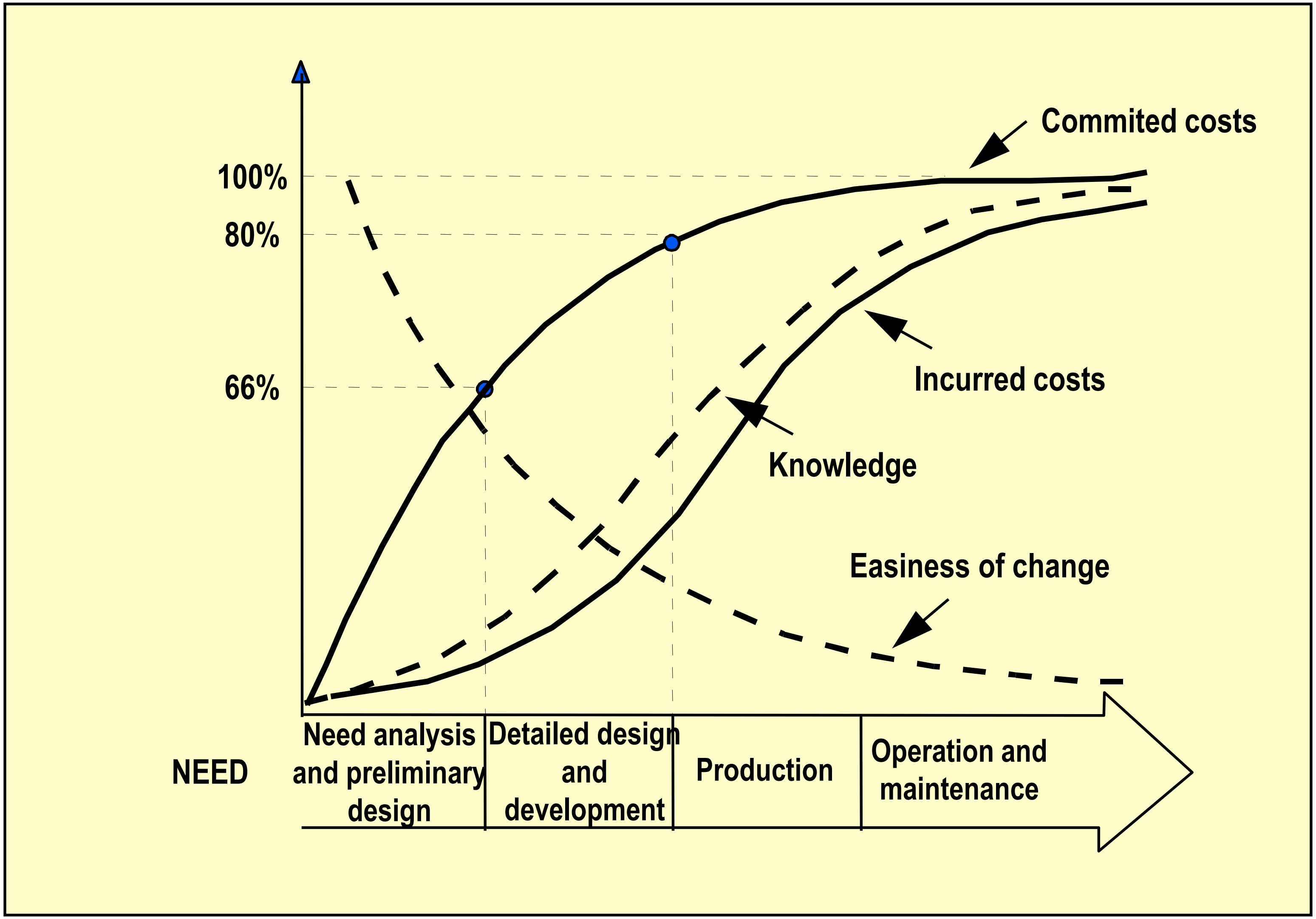
Operation and maintenance cost

- Management cost
- Deployment and commissioning cost
- Utilization cost
- Maintenance cost
- System upgrades cost
- Documentation cost
- Ongoing logistics support cost

Disposal cost

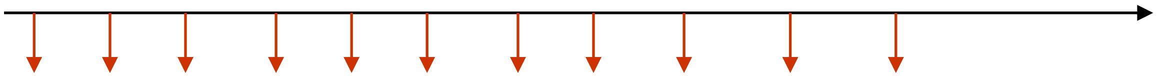
- Management cost
- System phase-out cost
- Documentation cost
- Special facilities cost

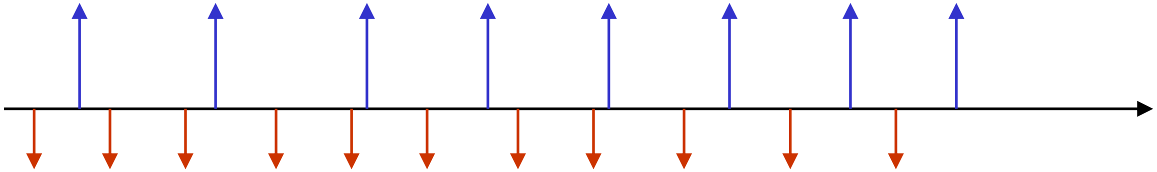
Life-cycle cost



Life-cycle cost

- *Strictu sensu*, life-cycle cost should only be used for systems with which the user does not seek the making of a profit
- When the user intends to materialize a profit through the use of a system, then it is more appropriate to talk about life-cycle economic profile.

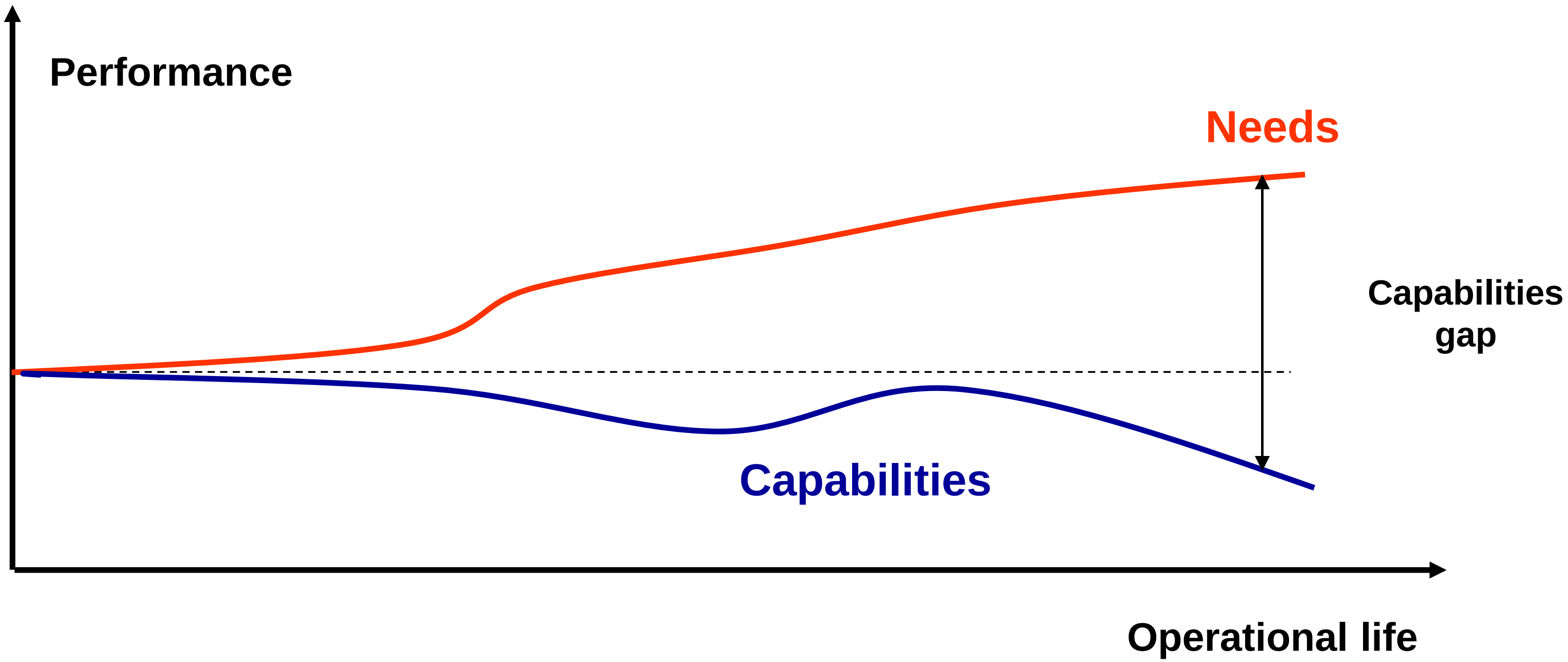


Analysis paralysis

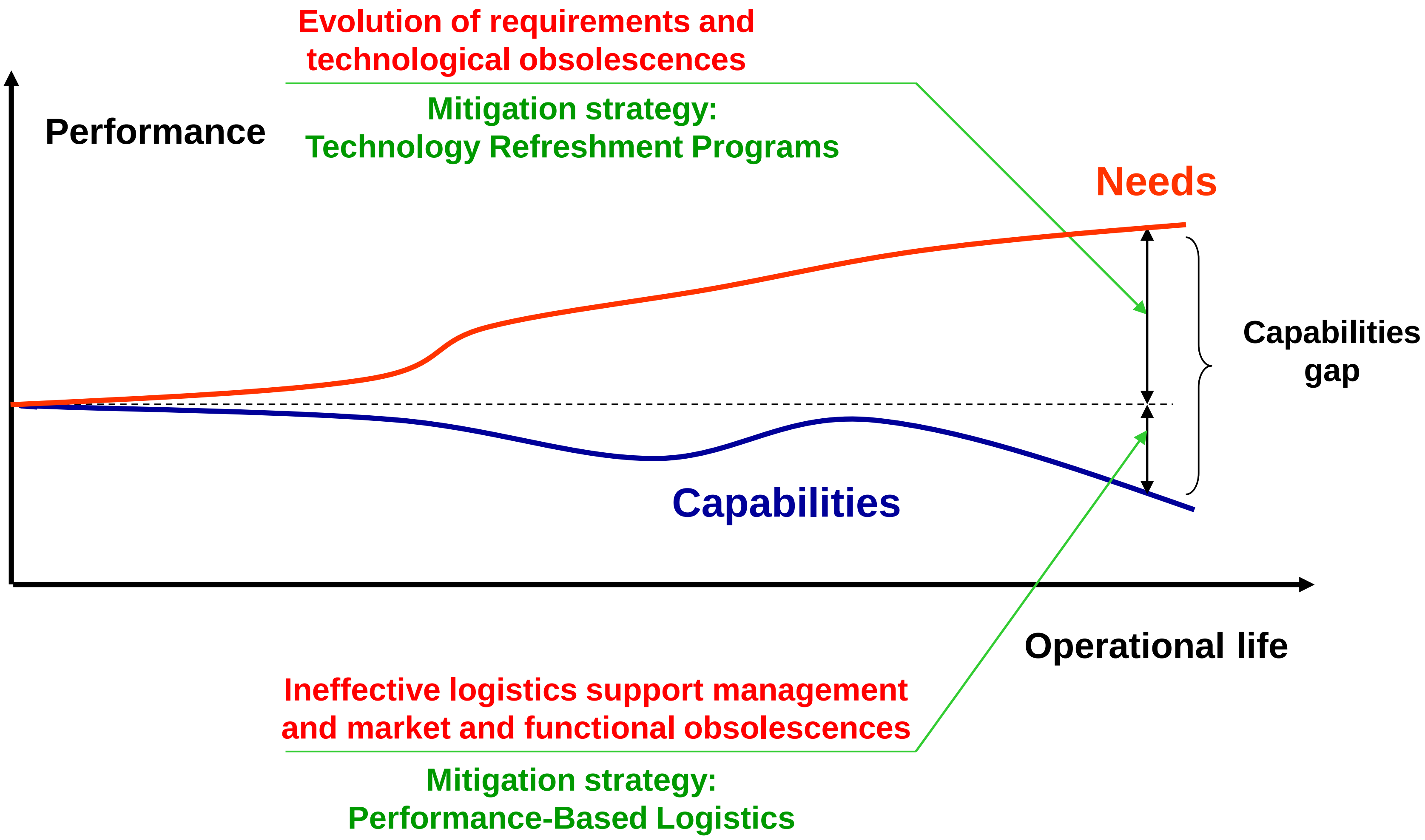
- As important as having a global view is avoiding the so-called *analysis paralysis,* situation in which the opportunity cost of the analysis exceeds by large the additional benefits to be expected from it.

- He who does not decide does not err …... but does not get anywhere either!

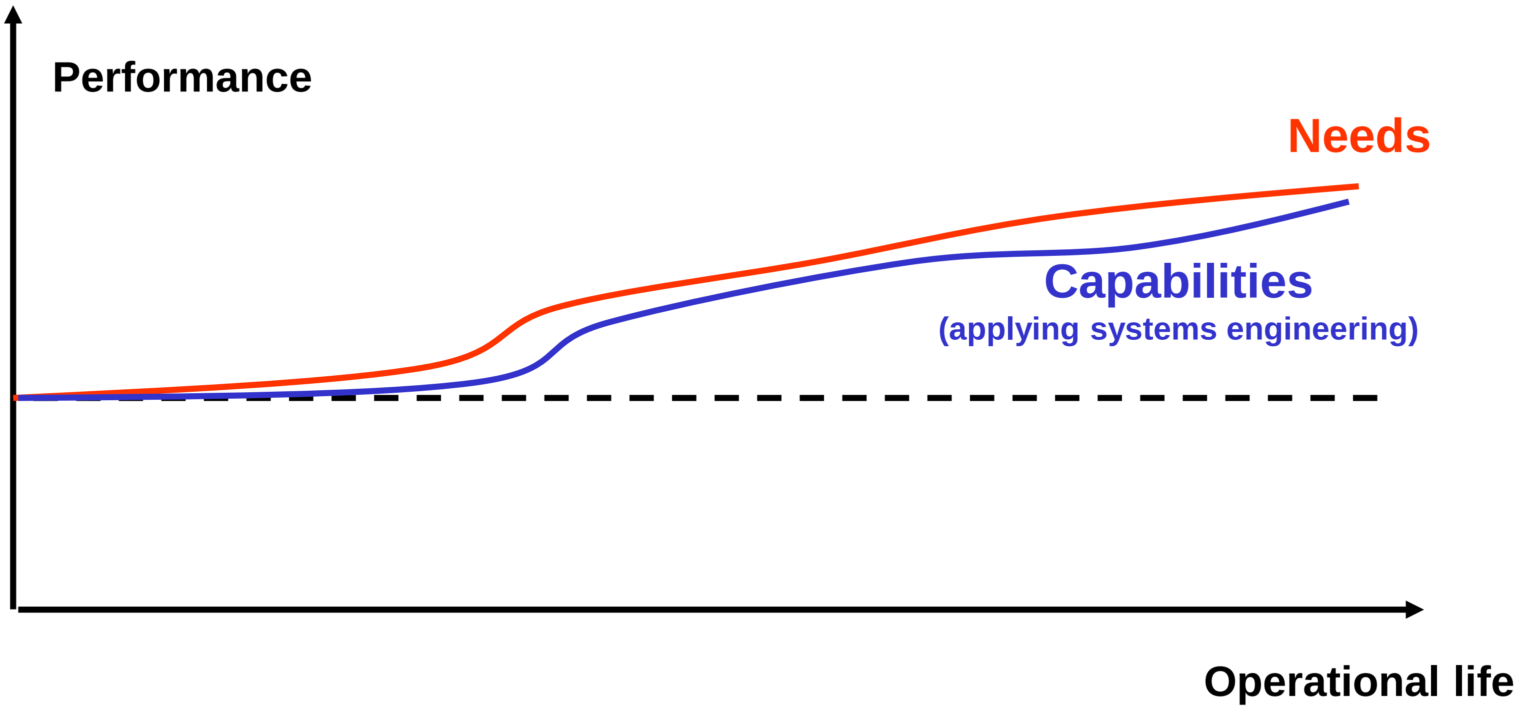
Capabilities gap



Capabilities gap



Capabilities gap



Holistic view of the systems

Systems ?

http://www.youtube.com/watch?v=JKUycuyGj7I&feature=player_embedded#